CLINICAL DETERMINANTS AND PATTERN OF BLOOD AND BLOOD COMPONENT TRANSFUSION IN NEONATES

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I hereby declare that the thesis entitled **"CLINICAL DETERMINANTS AND PATTERN OF BLOOD AND BLOOD COMPONENT TRANSFUSION IN NEONATES"** submitted towards partial fulfillment of the requirements for the award of **MD IMMUNO HEMATOLOGY AND BLOOD TRANSFUSION** degree to BFUHS is a compilation of original work carried out by me under the supervision of **Dr. Amarjit Kaur,** Professor & Head, Department of I.H.B.T., **Dr. Rajesh Kumar**, Professor, Department of I.H.B.T., & **Dr. Kamaldeep Arora,** Associate Professor, Department of Pediatrics. No part of this thesis has formed the basis for the award of any degree previously.

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Dedicated

to

my beloved mother,

Shashi Sharma

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LIST OF ABBREVIATIONS

1. **NICU** : NEONATAL INTENSIVE CARE UNIT
2. **RBC** : RED BLOOD CELLS
3. **BCSH** : BRITISH COMMITTEE FOR STANDARDS IN HAEMATOLOGY
4. **NNF** : NATIONAL NEONATOLOGY FORUM
5. **AABB** : AMERICAN ASSOCIATION of BLOOD BANKS
6. **PRBC** : PACKED RED BLOOD CELLS
7. **FFP** : FRESH FROZEN PLASMA
8. **RDP** : RANDOM DONOR PLATELET
9. **DIC** : DISSEMINATED INTRAVASCULAR COAGULATION
10. **ELBW** : EXTREMELY LOW BIRTH WEIGHT
11. **VLBW** : VERY LOW BIRTH WEIGHT
12. **LBW** : LOW BIRTH WEIGHT
13. **TT-CMV** : TRANSFUSION-TRANSMITTED CYTOMEGALOVIRUS
14. **TA-GVHD** : TRANSFUSION-ASSOCIATED GRAFT-VERSUS-HOST DISEASE
15. **EPO** : ERYTHROPOIETIN
16. **ESAs** : ERYTHROPOIESIS-STIMULATING AGENTS
17. **NEC** :NECROTISING ENTEROCOLITIS
18. **ICH** : INTRACRANIAL HEMORRHAGE
19. **ECMO** : EXTRACORPOREAL MEMBRANE OXYGENATION
20. **SP** : SATELLITE PACKS
21. **DE** : DONOR EXPOSURE
22. **BG** : BLOOD GROUP
23. **ACHD** :ACYANOTIC CONGENITAL HEART DISEASE
24. **RDS** : RESPIRATORY DISTRESS SYNDROME
25. **MV** : MECHANICAL VENTILATION
26. **CPAP** :CONTINUOUS POSITIVE AIRWAY PRESSURE

27. **NC** **:** NASAL CANNULA
28. **NOP** **:** NASAL OXYGEN PRONGS
29. **S.S** **:** SEPSIS WITH SHOCK
30. **Hb** **:** HEMOGLOBIN
31. **INR** **:**INTERNATIONAL NORMALIZED RATIO
32. **Plt** **:** PLATELETS
33. **CPS** **:** CARDIO PULMONARY SYNDROME
34. **TR** **:**TRANSFUSION REACTION
35. **LAMA** **:** LEFT AGAINST MEDICAL ADVISE
36. **GA** **:** GESTATIONAL AGE
37. **ACOG** **:** AMERICAN COLLEGE OF OBSTETRICIANS AND GYNAECOLOGISTS
38. **APGAR** **:** APPEARANCE, PULSE, GRIMACE, ACTIVITY AND REFLEX
39. **NHS** **:** NATIONAL HEALTH SERVICES
40. **IUGR** **:** INTRAUTERINE GROWTH RESTRICTION
41. **AAP** **:** AMERICAN ACADEMY OF PEDIATRICS
42. **PTB** **:** PRETERM BIRTH

ABSTRACT

Introduction: Neonates treated in neonatal intensive care units are commonly transfused. Sepsis, hyperbilirubinemia, repeated phlebotomy, coagulopathies, G6PD deficiency are common determinants of transfusion. It is required to maintain life, by increasing the cardiac output and oxygen delivery to tissues, and removing toxins like bilirubin from the body. Due to smaller volumes, transfusion services need to be directed at neonates in a special manner.

Objective:

- To determine the clinical indications for blood and blood component transfusion in neonatal population.
- To standardize the protocols for blood transfusion based on statistical data.

Methods: All neonates transfused with blood or blood components were identified and followed through the hospital stay. Clinical determinants of transfusion, pre and post transfusion hemogram, transfusion related complications and final outcomes were recorded.

Results: Multiple gestation, low birth weight and prematurity were major determinants of transfusion in neonates due to more comorbidities in this population. Most subjects were transfused within first 2 weeks of life. PRBC was the most commonly transfused blood component followed by RDP and FFP. Majority of the transfused subjects were discharged in satisfactory condition therefore, transfusion improved outcome in neonates.

Conclusions: Neonatal transfusion requirement depends on physiological changes after birth as well as pathological factors. Non restricted transfusion policies improve outcomes in neonates.

In our study, gestational age, birth weight and number of babies had a significant association with transfusion requirement. Very low birth weight premature neonates need most frequent and multiple transfusions.

Key words: Neonate, Transfusion, Prematurity, Birth weight, multiple gestations.

TABLE OF CONTENTS

S.NO.	TOPIC	PAGES
I	INTRODUCTION	1-4
II	AIMS AND OBJECTIVES	5
III	REVIEW OF LITERATURE	6-25
IV	MATERIALS AND METHODS	26-30
V	OBSERVATIONS AND RESULTS	31-88
VI	DISCUSSION	89-96
VII	SUMMARY AND CONCLUSIONS	97-99
VIII	BIBLIOGRAPHY	100-106

APPENDICES–I

- PROFORMA
- MASTER CHART

APPENDICES–II

- APPROVAL LETTER OF THESIS PLAN
- THESIS PLAN

LIST OF TABLES

TABLE NO.	TITLE	PAGE NO.
I	PRBC GUIDLINES	16,17,18
II	PLATELET GUIDELINES	19,20
III	FRESH FROZEN PLASMA GUIDLINES	21,22
IV	DOSAGE	23
1.1	SEX	31
2.1	AGE OF GESTATION	32
2.2	AGE OF GESTATION	33
3.1	BABY BLOOD GROUP	34
4.1	BIRTH WEIGHT	35
4.2	BIRTH WEIGHT	36
5.1	APGAR SCORE (0 MINUTES)	38
5.2	APGAR SCORE (5 MINUTES)	39
6.1	SINGLETON AND MULTIPLE GESTATION	40
7.1	PREMATURITY	41
7.2	RESPIRATORY DISTRESS SYNDROME	42
7.3	NEONATAL HYPERBILIRUBINEMIA	43
7.4	NECROTISING ENTEROCOLITIS	44
7.5	CONGENITAL MALFORMATIONS	45
7.6	OTHER CONGENITAL MALFORMATIONS	46
7.7	NEONATAL COMORBIDITIES	48
8.1	RESPIRATORY SUPPORT	50
8.2	RESPIRATORY SUPPORT	51
8.3	TREND OF CHANGE IN RESPIRATORY SUPPORT	53
9.1	AGE ON THE DAY OF 1ST TRANSFUSION	55
10	INDICATIONS OF TRANSFUSION	57
11	PATTERN OF PRBC TRANSFUSION	59
12	PATTERN OF FFP TRANSFUSION	61
13	PATTERN OF RDP TRANSFUSION	62
14.1	TRANSFUSION PATTERN IN SINGLETON VS MULTIPLE NEONATES	63
15.1	SINGLE & MULTIPLE TRANSFUSION	64
15.2	SINGLE & MULTIPLE TRANSFUSION	65
16.1	TRENDS OF COMPONENT TRANSFUSION	67
16.2	TRENDS OF COMPONENT TRANSFUSION	69
17.1	TRANSFUSION REACTION (T.R)	71
17.2	NECROTISING ENTEROCOLITIS (NEC)	72
17.3	DISTRESS	73
17.4	OTHER	74
17.5	NO COMPLICATION	75
18.1	OUTCOME	77
18.2	OUTCOME	79

18.3	OUTCOME	80
18.4	OUTCOME	82
18.5	OUTCOME	84
19.1	INCREASE IN Hb AFTER PRBC TRANSFUSION	86
20.1	DECREASE IN INR AFTER FFP TRANSFUSION	87
21.1	INCREASE IN PLATELET COUNT AFTER RDP TRANSFUSION	88
22	SEX	89
23	GESTATIONAL AGE (GA)	90
24	BIRTH WEIGHT	90
25	NUMBER OF BABIES	91
26	NEED FOR RESPIRATORY SUPPORT	93
27	PATTERN OF TRANSFUSION	94

LIST OF FIGURES

FIGURE NO.	TITLE	PAGE NO.
I	APGAR SCORING SYSTEM	8
II	STRATEGIES TO REDUCE DONOR EXPOSURE IN NEONATES	25
1.1	SEX	31
2.1	AGE OF GESTATION	32
2.2	AGE OF GESTATION	33
3.1	BABY BLOOD GROUP	34
4.1	BIRTH WEIGHT	35
4.2	BIRTH WEIGHT	37
5.1	APGAR SCORE (0 MINUTES)	38
5.2	APGAR SCORE(5 MINUTES)	39
6.1	SINGLETON AND MULTIPLE GESTATION	40
7.1	PREMATURITY	41
7.2	RESPIRATORY DISTRESS SYNDROME	42
7.3	NEONATAL HYPERBILIRUBINEMIA	43
7.4	NECROTISING ENTEROCOLITIS	44
7.5	CONGENITAL MALFORMATIONS	45
7.6	OTHER CONGENITAL MALFORMATION	46
7.7	NEONATAL COMORBIDITIES	49
8.1	RESPIRATORY SUPPORT	50
8.2	RESPIRATORY SUPPORT	52
8.3	TREND OF CHANGE IN RESPIRATORY SUPPORT	54
9.1	AGE ON THE DAY OF 1ST TRANSFUSION	55
10	INDICATIONS OF TRANSFUSION	58
11	PATTERN OF PRBC TRANSFUSION	60
12	PATTERN OF FFP TRANSFUSION	61
13	PATTERN OF RDP TRANSFUSION	62

14.1	TRANSFUSION PATTERN IN SINGLETON VS MULTIPLE NEONATES	63
15.1	SINGLE & MULTIPLE TRANSFUSION	64
15.2	SINGLE & MULTIPLE TRANSFUSION	66
16.1	TRENDS OF COMPONENT TRANSFUSION	67
16.2	TRENDS OF COMPONENT TRANSFUSION	70
17.2	NECROTISING ENTEROCOLITIS (NEC)	72
17.3	DISTRESS	73
17.5	NO COMPLICATION	75
18.1	OUTCOME	78
18.2	OUTCOME	79
18.3	OUTCOME	81
18.4	OUTCOME	83
18.5	OUTCOME	85
19.1	INCREASE IN Hb AFTER PRBC TRANSFUSION	86
20.1	DECREASE IN INR AFTER FFP TRANSFUSION	87
21.1	INCREASE IN PLATELET COUNT AFTER RDP TRANSFUSION	88

KEY TO MASTER CHART

ALL M : MALE

ALL F : FEMALE

ALL Y : YES

ALL N : NO

SINGLETON AND MULTIPLE GESTATION?

1 : SINGLETON

2 : TWINS

3 : TRIPLETS

Tfn. : TRANSFUSION

BIRTH WEIGHT:

NW : NORMAL WEIGHT

LBW : LOW BIRTH WEIGHT

VLBW : VERY LOW BIETH WEIGHT

ELBW : EXTREMELY LOW BIRTH WEIGHT

BIRTH WEIGHT GROUP:

1 : EXTREMELY LOW BIRTH WEIGHT

2 : VERY LOW BIETH WEIGHT

3 : LOW BIRTH WEIGHT

4 : NORMAL WEIGHT

AGE OF GESTATION:

1 : ≤32 WEEKS

2 : >33 to <36 WEEKS

3 : ≥36 WEEKS

Hb : hemoglobin

TLC : TOTAL LEUKOCYTE COUNT

PLT : PLATELET

BIL : BILIRUBIN

NEO HYPERBIL : NEONATATL HYPERBILIRUBINEMIA

CONG MALF : CONGENITAL MALFORMATION

M.V : MECHANICAL VENTILATION

CPAP : CONTINUOUS POSITIVE AIRWAY PRESSURE

NC	: NASAL CANNULA
NOP	: NASAL OXYGEN PRONGS
T.PENIA	: THROMBOCYTOPENIA
SURG	: SURGERY
COAG	: COAGULOPATHY
CPS	: CARDIOPULMONARY SYNDROME
Rh INCOMP	: Rh INCOMPATIBILITY
BG	: BLOOD GROUP
TR	: TRANSFUSION REACTION
NEC	: NECROTISING ENTEROCOLITIS

INTRODUCTION

A child less than 28 days old is known as a newborn infant, neonate, or newborn. During these first 28 days of life, the mortality rate is high. The vast majority of newborn deaths take place in developing countries where access to health care is low.[1] In the last century, blood transfusions have transformed healthcare, and this also applies to the neonatal population. A vital component of medical care is blood transfusion, especially in neonates, where common disorders are frequently accompanied by blood loss or destruction. The procedure replaces the volume and the specific constituents of blood, which play specific roles in oxygen carriage, immunity, and clotting.[2]

During the transition from a fetus to a neonate, several physiologic changes occur, involving blood volume, hematologic parameters and other organ systems in the neonate.[3]

Neonatal transfusion requirements might result from physiological or pathological factors. The hematological domains of the newborn's body may alter quickly as a result of their rapid growth. The leading causes of neonatal morbidities and mortality in the developing world include prematurity, infections and malformations. With prompt and safe blood transfusion support, many of these fatalities can be avoided.

In order to weigh the benefits and hazards of transfusions, it is crucial that neonates receive appropriate transfusions.[4]

Instead of following explicit, written guidelines, neonates are frequently transfused depending on the clinical judgement of experts. Neonatal transfusion practice is in dispute because there aren't enough statistically significant clinical trials.[5] and only a few guidelines exist. Infants with extremely low birth weights are more susceptible to transfusion since they already have impaired immune systems and are still developing neurologically.[4]

Due to their prolonged stays in the NICU and frequent sampling, newborns admitted to a tertiary NICU frequently need blood transfusions the neonate's inexperienced organ systems and small blood volumes necessitate routine assessments of newborn blood transfusion procedures.[5]

The basis for transfusion therapy indications in the neonatal period is a thorough understanding of a variety of aspects of this stage of life, including the dynamic interaction between the mother, placenta, foetus, and neonate, the pathophysiological changes in the perinatal and neonatal periods, and the profound hematological changes that are typical of the first few weeks of life.[6]

Inherently low erythropoietin and iron levels, shorter RBC life expectancy, deficiency of vitamin K leading to low level of clotting factors are all responsible for requirement of blood and blood component transfusion in neonates.

The reasons are typically self-limited and well tolerated, but intervention may be necessary in some cases, such as blood loss brought on by repeated phlebotomy, infection, and severe anemia. Transfusion triggers for neonates will vary depending on the clinical context, including the gestational age at birth. Neonatal transfusion guidelines have generally been developed as a result of neonatal studies predominantly of very low birth weight (VLBW; < 32 weeks gestational age; National Comparative Audit of Blood Transfusion, 2010), some of whom will require transfusion beyond 28 days of life[3]

The blood volume in a full term new born is approximately 85 ml/kg, while that in a preterm new born is about 100 ml/kg and that in an adult is about 70 ml/kg.[3]

Neonatal transfusion technique requires specialized methods due to the newborn's limited blood volume and underdeveloped organ systems.

The most frequent indications for blood transfusion in the newborn are the acute treatment of perinatal hemorrhagic shock and the recurrent

correction of anemia of prematurity. Perinatal hemorrhagic shock requires immediate treatment with large quantities of red blood cells.

Anemia of prematurity is, in part, an exacerbation of the physiological anemia of the newborn, combining a suppressed postnatal response to erythropoietin, increased blood sampling, short RBC span in the newborn and the rapid increase in blood volume with growth.[7] Apart from hemoglobin or hematocrit, there are no satisfactory clinical or laboratory guides to assist the decision to transfuse.[8]

Preterm infants with very low birth weight have very little iron stores and a small circulating volume of RBCs when they exit the uterine stage.[9]

Physiologically, healthy full-term neonates have a mean cord blood hemoglobin level of 16.9 ± 1.6 g/dL and that of preterm neonates is 15.9 ± 2.4 g/dL.[10] During the first few weeks of life, the hemoglobin concentration typically declines, causing physiological anemia in newborns and physiological preterm anemia in preterm infants. As can be expected with low reserves and small circulatory volumes, the effects of loss of even small blood volumes can be profoundly lethal for the neonates.

Platelet production in the fetus begins around 5 weeks after conception and by the end of the second trimester has established the normal postnatal range of 150-450 × 10^9/l.[11]

Newborns may have "early-onset" or "late-onset" thrombocytopenia, developing during the first three postnatal days, or at any other time after this respectively. Prophylactic transfusion is initiated at higher platelet thresholds in the USA and Canada compared to European treatment, where there is less evidence and disagreement on optimal platelet transfusion thresholds in newborn therapy. Preventing periventricular hemorrhage in a premature newborn is the main priority.

Taking into account that platelets in newborns may be less hemostatic[10], and that both adults and neonates in intensive care are at greater clinical risk of bleeding as a consequence of interventions and clinical instability, the British Committee for Standards in Haematology (BCSH) advised, in 2004, a prophylactic platelet threshold for stable preterm and term infants of 20×10^9/l and of 30×10^9/l for sick neonates.

The indications for transfusions of fresh frozen plasma (FFP) in neonates are also unclear. Common indications for plasma transfusion include reconstitution of whole blood for exchange transfusion and active bleeding in disseminated intravascular coagulation (DIC)[12]

There is a severe lack of evidence supporting FFP's efficacy in newborns. It is not deemed suitable to employ this blood component in sepsis or as a volume expander in neonates with hypotension.

The administration of FFP as a strategy to prevent intracranial hemorrhage has not been shown to be beneficial and is not, therefore, indicated.[11] Current evidence support the administration of FFP to neonates in limited conditions, including the treatment of bleeding associated with coagulopathy, disseminated intravascular coagulation, and inherited deficiencies of coagulation factors when replacement products are not available.[12]

Several schools of thought on indications and recommendations regarding blood and blood component transfusion in neonates call for a data based study to verify the effects of transfusion in neonates.

AIMS AND OBJECTIVES

- To determine the clinical indications for blood and blood component transfusion in neonates
- To formulate the protocols for blood transfusion based on statistical data.

REVIEW OF LITERATURE

According to the NHS Data Model and Dictionary, neonatal period commences on the person birth date (BABY) and ends 28 completed days after birth.[12] A newborn infant or neonate, is defined as a child under 28 days of age[1] Newborn infants are the most heavily transfused population inside intensive care units.[13]

Infants, particularly those who were very small premature neonates, are among the most common of all patient groups to undergo extensive transfusion. It is estimated that approximately 300,000 neonates undergo transfusions annually.[14]

CATEGORIES OF NEONATES

Preterm birth is defined by WHO as all births before 37 completed weeks of gestation or fewer than 259 days since the first day of a woman's last menstrual period. Preterm birth can be further sub-divided based on gestational age: extremely preterm (<28 weeks), very preterm (28 - <32 weeks) and moderate preterm (32 - <37 completed weeks of gestation). Moderate preterm birth may be further split to focus on late pre-term birth (34 - <37 completed weeks). The 37 week cut off is somewhat arbitrary, and it is now recognized that whilst the risks associated with preterm birth are greater the lower the gestational age, even babies born at 37 or 38 weeks have higher risks than those born at 40 weeks gestation.[15]

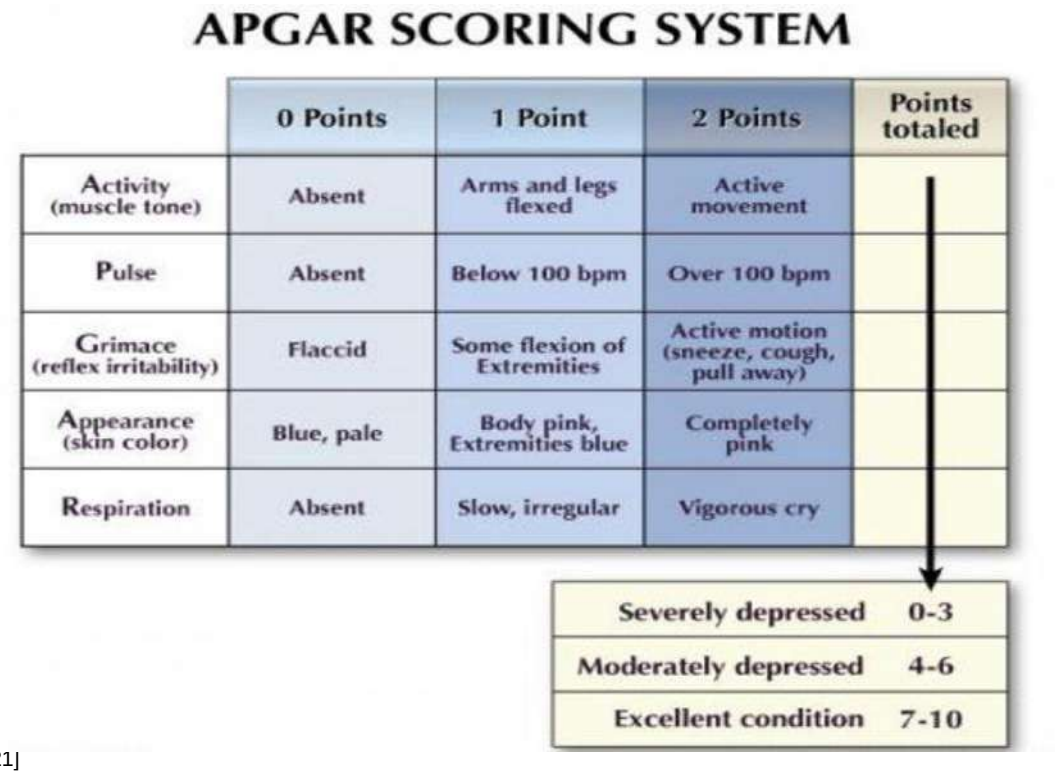
Neonates can also be classified according to birth weight. The birth weight of an infant is the first weight recorded after birth, ideally measured within the first hours after birth, before significant postnatal weight loss has occurred.[16] Weight at birth can be classified into three categories, that is normal (birth weight ≥2.5 kg < 4.0 kg), too light or low birth weight (birth weight < 2.5 kg) or too heavy (macrosomia) (birth weight ≥ 4.0 kg).[17]

Low birth weight has been defined by WHO as weight at birth of < 2500 grams (5.5 pounds).[18]Low birth weight is a result of preterm birth (PTB, short gestation <37 completed weeks), intrauterine growth restriction (IUGR, also known as fetal growth restriction), or both.[16]

APGAR SCORE

In 1952, Dr. Virginia Apgar, an anesthesiologist at Columbia University, developed the Apgar score. Serendipitously, APGAR is also a useful mnemonic to describe the components of the score: appearance, pulse, grimace, activity, and respiration. The score is a rapid method for evaluating neonates immediately after birth and in response to resuscitation. Apgar scoring remains the accepted method of assessment and is endorsed by both the American College of Obstetricians and Gynecologists (ACOG) and the American Academy of Pediatrics (AAP)[19]

The Apgar score provides an accepted and convenient method for reporting the status of the newborn infant immediately after birth and the response to resuscitation if needed.[20] It acts as a predictive value for the outcome of the newborn.



[21]

FIGURE- I APGAR SCORING SYSTEM

BLOOD TRANSFUSION IN NEONATES

Neonates are among the patients undergoing transfusion most frequently during hospitalization. More than 90% of extremely low birth weight (ELBW) infants weighing less than 1,000g are estimated to receive at least 1 red blood cell (RBC) transfusion during a neonatal intensive care unit (NICU) stay.[22]

Sick neonates are one of the most heavily transfused groups of patients in modern medicine.[23]The indications for transfusion therapy in the neonatal period are based on specific knowledge of various aspects of this particular hematological modifications that are characteristic of the first weeks of life.[1,4,6]

The scientific contributions on transfusion medicine in the neonatal period derive predominantly from consensus of opinions rather than controlled studies and the lack of clear scientific evidence makes it difficult to formulate high-grade recommendations based on solid levels of

evidence.[11]

Neonatal transfusion practices are substantially different from adult and pediatric transfusion practices due to the unique physiological characteristics of neonates. First, the prenatal transfer of maternal antibodies to the immunologically immature neonate results in unique hematologic compatibility patterns different from those of other age groups. Second, immature organ function exposes the neonates to metabolic complications and to infectious and immunologic complications, such as transfusion-transmitted cytomegalovirus (TT-CMV) infection and transfusion-associated graft-versus-host disease (TA-GVHD). Third, neonates are at a higher risk of hemodynamic instability because of a small blood volume and the limited capacity to increase the blood volume relative to rapid growth[24]

The physiology of the fetus is fundamentally different from the neonate, with both structural and functional distinctions. The fetus is well-adapted to the relatively hypoxemic intrauterine environment.[25]

The transition from fetus to newborn is the most complex adaptation that occurs in human experience. Lung adaptation requires coordinated clearance of fetal lung fluid, surfactant secretion, and onset of consistent breathing. The cardiovascular response requires striking changes in blood flow, pressures, and pulmonary vasodilation. Abnormalities in adaptation are frequently found following preterm birth or cesarean delivery at term.[26] The change is complicated and neonates may have poor outcomes due to complications during this time.

Blood is an integral part of the neonate’s system and transfusions are essential life saving therapy.

Blood transfusion is the process of infusion of blood or blood component into an individual’s circulatory system.[27] Blood transfusion is used in a variety of medical conditions to replace the lost components of blood or to compensate missing ones.

Transfusion of whole blood creates hazards to the patients which were

noted in the past few decades. So transfusion of blood components has been considered, to be a low risk and safe procedure.[28]

The blood transfusion need in the neonate is huge because of reduced marrow activity in the neonatal period. Other indications include correction of anemia, exchange blood transfusion or partial exchange transfusions for removal of bilirubin, removal of antibodies and replacement of red cells, replacement of losses due to blood loss during blood sample collection for various tests. Blood products such as platelet concentrates and fresh frozen plasma can also be transfused in septicemic neonates with DIC and neonates with bleeding diathesis.[27]

Transfusion improves overall outcomes in these rookie patients.

Anemia of prematurity is a physiological phenomenon, which is related to the inadequate materno-fetal transfer of iron and poor postnatal production of endogenous erythropoietin in infants. Although, replacement therapy with synthetic erythropoietin is a common practice in the developed world, blood transfusion is commonly used in parts of the developing world, where recombinant erythropoietin is unavailable.[2]

NEONATAL PHYSIOLOGY AFFECTING BLOOD TRANSFUSION DECISIONS:

1) PREMATURITY

In preterm neonate, because of the lack of complete development of hematopoiesis and adaptation to extra uterine life there is a decreased capacity to produce red blood cells (RBCs), platelets, and neutrophils — this is of increased relevance during a life-threatening illness such as sepsis, severe pulmonary dysfunction, necrotizing enterocolitis, and immune cytopenia. In the same way, liver function is immature resulting in low levels of both plasma clotting and anticoagulant factors. Thus, preterm infants begin life with low levels of RBC and other vital factors in blood. Furthermore, their ability to increase production of RBCs and other clotting

factors in severely impaired due to immature or ill developed organs systems. These conditions lead to the need for blood component transfusions[9]

2)PHYSIOLOGICAL ANEMIA AND ANEMIA OF PREMATURITY

During the first two months after birth, the concentration of hemoglobin declines rapidly from the highest to the lowest values that occur at any period of development. The low point is termed the physiologic anemia of infancy. It is considered physiologic because it is characteristic of healthy infants, it occurs in the absence of any recognized nutritional deficiency, and there is no sustained response to blood transfusion.[29] A hemoglobin concentration of 15 g/dl appears optimal for preterm and full-term infants at birth as well as for adults. The calculated minimum acceptable hemoglobin concentration is 6 g/dl for children and adults, 12 g/dl for preterm infants and 11 g/dl for full-term neonates at birth. Due to the postnatal decrease in oxygen affinity, the minimum acceptable hemoglobin concentration decreases by approximately 1 g/dl/week for the first 5-6 weeks until the minimum value of 6 g/dl for children and adults is reached. The minimum hemoglobin concentration should be 2 g/dl higher in patients who require increased oxygen or suffer from other serious disorders.[30]

3) INFANT SIZE AND BLOOD VOLUME

A term newborn has a blood volume of approximately 85 mL/kg compared to 100 mL/kg in a preterm newborn. Due to the small total blood volumes of preterm infants (100 mL or less), the size of blood components need to be appropriate. Many factors, including blood loss from repeated sampling, lead to frequent transfusions. Hypovolemia is poorly tolerated in newborns because their left ventricular stroke volume decreases without a corresponding increase in heart rate when >10% of their blood volume is lost. Thus, newborns must physiologically increase their peripheral

vascular resistance with decreasing cardiac output to maintain systemic blood pressure. This leads to impaired tissue perfusion and oxygenation, which may end in metabolic acidosis.[31]

4) ERYTHROPOIETIC RESPONSE

Preterm infants have low plasma levels of erythropoietin (EPO), providing a rationale for the use of erythropoiesis-stimulating agents (ESAs) to prevent or treat anaemia and to provide neuro protection and protection against necrotizing enterocolitis (NEC). Darbepoeitin and EPO are currently available ESAs.[32]

5)HYPOTHERMIA

Hypothermia in the neonate can activate or amplify several responses, which includes 1) an increase in metabolic rate; 2) hypoglycaemia; 3) metabolic acidosis; and 4) potential apnoeic events that may lead to hypoxia, hypotension, and cardiac arrest. In-line blood warmers are needed for all Red Blood Cell (RBC) exchange transfusions to counteract the effects of hypothermia. Because of the risk of hemolysis radiant heaters for blood should not be used[31]

6) PLATELETS IN A NEONATE

The normal range for platelet count in newborns and infants is 150 × 10^3 to 450 × 10^3/µL, although some data suggest a slightly lower limit of normal, particularly in preterm infants. Platelet counts decline over the first few days after birth but then begin to rise by 1 week of life. In the general population, spontaneous bleeding from thrombocytopenia does not occur when platelets are above 100 × 10^3/µL. Risk of spontaneous bleeding is minimal to mild at counts of 20 × 10^3 to 100 × 10^3/µL, moderate between counts of 5 × 10^3 to 20 × 10^3/µL, and severe below counts of 5 × 10^3/µL. Newborns in particular may be predisposed to bleeding events as a result of recent trauma associated with the birthing process. The most

feared bleeding complication in the newborn population is intracranial hemorrhage (ICH), due to risk of death and adverse neurologic outcomes.[33]

7) HEMOSTASIS IN NEONATES

Clotting factors in the circulation of the newborn have been synthesised by the fetus and do not cross the placenta[34] The dynamic and evolving process of the hemostatic system that occurs during infancy and childhood was first described by Andrew and was termed “developmental hemostasis”.[35-36] In the immediate post-natal period too, infants are unable to produce normal levels of these proteins physiologically, and so low levels of vitamin K dependent factors (Factors II, VII, IX, and X) and contact factors (Factor XI, Factor XII, prekallikrein, and high-molecular-weight kininogen) contribute to altered coagulation test results. Also, the naturally occurring vitamin K dependent anticoagulants (proteins C and S) and the non-vitamin K dependent antithrombin protein are at reduced levels at birth. Despite these variations from adult levels of coagulation proteins, the procoagulant and anticoagulant systems are usually in balance in healthy newborns, so spontaneous bleeding and thrombosis are rare. However, the reserve capacity of both procoagulant and anticoagulant systems are limited as compared to that in an adult. [31,37]

INDICATIONS OF TRANSFUSION

RBC TRANSFUSIONS

PRBCs are the most commonly used blood product in neonatal transfusions[23] Indications for transfusion of PRBCs are mainly for resolution of symptomatic anemia and improvement of tissue oxygenation. Tissue oxygenation depends on cardiac output, oxygen saturation and hemoglobin concentration. Once cardiac output and oxygen saturation are optimal, tissue oxygenation can only be improved by increasing the

hemoglobin level. The guidelines for transfusion of PRBC vary according to age, level of sickness and hematocrit.[38]

PLATELET TRANSFUSIONS

A number of large studies have shown that the fetal platelet count is above 150 × 10^9 /l by the second trimester of pregnancy,3–6 and then remains fairly constant until term. Therefore the normal platelet count of all healthy newborn infants, regardless of gestational age, should be 150 × 10^9 /l and above, and counts below this represent thrombocytopenia, just as in older children and adults.[39] The incidence of thrombocytopenia is inversely proportional to the gestational age, and it represents a risk factor for poor neonatal outcomes.[40]

Platelet transfusion remains the primary treatment modality for neonatal thrombocytopenia, but there is lack of agreement regarding the platelet count below which a newborn infant should be transfused. Nevertheless, it has been widely accepted that neonates should be transfused at higher platelet counts than older children and adults, and thus platelet transfusions are a frequent intervention in the NICU.[41]

PLASMA TRANSFUSION

Spontaneous bleeding and thrombosis are rare in term healthy neonates because the procoagulant and anticoagulant systems are usually in equilibrium with each other. However, the reserve capacity for both systems is limited. Therefore, serious bleeding may occur in sick premature infants during the first week of life. In older children and adults, coagulopathy is often defined as a PT or aPTT greater than 1.5 times the mid-point of normal range, but this is more difficult to apply in neonates, especially in very preterm neonates given that the ranges may be uncertain and broad. Common indications for plasma transfusion include reconstitution of whole blood for exchange transfusion and active bleeding in disseminated intravascular coagulation (DIC). The use of prophylactic

plasma transfusions to prevent intracranial hemorrhage (ICH) in preterm neonates is again controversial[31]

Infusions of FFP in neonates is effective in reducing blood loss associated with extracorporeal membrane oxygenation (ECMO) or cardio-pulmonary bypass and to treat active bleeding due to DIC, liver failure or Vitamin K deficiency.[37]

GUIDELINES FOR TRANSFUSION PRACTICES IN NEONATES:

Neonatal transfusion guidelines are repeatedly changed as new data become available and remain an area of debate[42] Due to general fragility of the neonates it is difficult to form data based guidelines that can be applied universally.

TABLE – I PRBC GUIDELINES

<table>
<tr><th>NNF GUIDELINES</th><th>AABB GUIDELINES</th><th>BCSH GUIDELINES</th></tr>
<tr>
<td>Severe anemia of antenatal onset:
Anemia occurring before birth, characterized by Hb< 8/dL at birth, requires
prompt transfusion, as specified below
a. In severe anemia associated with
congestive heart failure (due to immunohemolysis,
chronic feto-maternal or feto-fetalhemorrhage)
the most appropriate treatment is "partial"
exchange transfusion (PET) with packed RBC
with the aim of correcting the anemia while
avoiding volume overload.
b. In severe anemia with hypovolaemic
shock (placenta previa, abruption placentae,
rupture of the cord), the intravascular volume
must be restored and the anaemia corrected.
Early neonatal anemia:
For anemia developing after</td>
<td>1. Haematocrit <20% with low reticulocyte count and symptomatic
anaemia (tachycardia, tachypnea, poor
feeding).
2. Haematocrit <30% and any of the
following:
a. On <35% oxygen hood.
b. On oxygen by nasal cannula.
c. On continuous positive airway
pressure and/or intermittent mandatory ventilation on
mechanical ventilation with mean
airway pressure <6 cm of water.
d. With significant tachycardia or
tachypnea (heart rate >180 beats/minute for 24 hours,
respiratory rate >80 beats/minute
for 24 hours).
e. With significant apnea or bradycardia (>6 episodes in 12 hours or 2 episodes in 24 hours
requiring bag and mask ventilation while receiving</td>
<td>
<table>
<tr><th rowspan="2">Postnatal age</th><th colspan="3">Suggested transfusion threshold Hb (g/L)</th></tr>
<tr><th>Ventilated</th><th>On oxygen /NIPPV#</th><th>Off oxygen</th></tr>
<tr><td>1st 24 hours</td><td>< 120</td><td>< 120</td><td>< 100</td></tr>
<tr><td>≤week 1 (day 1-7)</td><td>< 120</td><td>< 100</td><td>< 100</td></tr>
<tr><td>week 2 (day 8 - 14)
 week 3 (day 15 onwards)</td><td>< 100</td><td>< 95
< 85</td><td>< 75*</td></tr>
</table>

* Standard definition of preterm is <37 weeks gestational age at birth but table applies to very preterm neonates (< 32 weeks).
** It is accepted that clinicians may use up to
85 g/L depending on clinical situation
</td>
</tr>
</table>

birth or in the first week of life, in which the values of Hb are moderately decreased, transfusion treatment is necessary in the case of severe cardio-pulmonary diseases, in order to maintain the PCV greater than 0.35 to 0.40. Late neonatal anaemia: a. Acute blood loss greater than 10% of blood volume with features of decreased oxygen delivery or greater than 20% of blood volume. b. PCV< 30%: Moderate or significant mechanical ventilator support [MAP >8 cm, FiO2 >0.40 with conventional ventilation or MAP > 14 and FiO2 > 0.40 with High frequency ventilation- HFV] c. PCV< 25%: Minimal mechanical ventilator support [MAP < 8 cm, FiO2 < 0.40 on conventional ventilation or MAP <14 and/or FiO2	therapeutic doses of methylxanthines). f. With low weight gain (<10 g/day observed over 4 days while receiving 100 kcal/kg/day). 3. Haematocrit <35% and either of the following: a. On >35% oxygen hood. b. On continuous positive airway pressure/intermittent mandatory ventilation with mean airway pressure 6-8 cm of water. 4. Haematocrit <45% and either of the following: a. On extracorporeal membrane oxygenation. b. With congenital cyanotic heart disease.	# NIPPV, non-invasive positive pressure ventilation

0.40 on HFV] d. PCV< 20%: Supplemental oxygen not requiring mechanical ventilatory support plus the presence of one or more of the following: i. Tachycardia >180/minute or Respiratory rate > 60 for □ 24hours ii. Doubling of the oxygen requirement in last 48 hours iii. Lactate > 2.5 mEq/L or acute metabolic acidosis with pH <7.20 iv. Weight gain less than 10 grams/kg/day over 4 days while receiving 120 kcal/kg/day v. If the infant will undergo major surgery within 72 hours e. PCV< 18%: Consider transfusion for asymptomatic infants with absolute reticulocyte count of < 100x103□□L (100x109/L) or < 2 percent.		

Table II- Platelet Transfusion Guidelines

NNF GUIDELINES

Platelets (x109/L)	Bleeding		Immune status	
	Yes	**No**	**AITP***	**NAIT#**
<30	Transfuse	Consider Platelet transfusion	Transfuse if bleeding/ IVIG not available	Transfuse If bleeding
30 to 49	Transfuse	Transfuse if Weight <1000grams or postnatal age <1week or Unstable (IVH Gr3-4) or associated coagulopathy or Surgery required	Transfuse, If unstable, bleeding	Transfuse If bleeding
50 to 99	Transfuse	Do not transfuse	Do not transfuse	Transfuse If bleeding

AABB GUIDELINES

With Thrombocytopenia

- Platelet count 5,000 to 10,000/µL

withfailure of platelet production.

- Platelet count <30,000/µL in neonate

with failure of platelet production.

- Platelet count <50,000/µL in stable

premature infant:
- With active bleeding, or
- Before an invasive procedure,

with failure of platelet production.

- Platelet count <100,000/µL in sick

premature infant:
- With active bleeding, or
- Before an invasive procedure in

patient with DIC.
Without Thrombocytopenia

- Active bleeding in association with

qualitative platelet defect.

- Unexplained excessive bleeding in a patient undergoing

BCSH GUIDELINES

Platelet count (x 10^9/l)	**Indication for platelet transfusion**
< 25	Neonates with no bleeding (including neonates with NAIT if no bleeding and no family history ofICH)
< 50	Neonates with bleeding, current coagulopathy, before surgery, or infants with NAIT if previously affected sibling with ICH

>99	Do not transfuse	cardiopulmonary b ypass. • Patient undergoing ECMO with: - A platelet count of <100,000/µL, or - Higher platelet counts and bleeding.	< 100	Neonates with major bleeding or requiring major surgery (e.g. neurosurgery)

* Autoimmune thrombocytopenia
# Neonatal Alloimmune thrombocytopenia

DIC = disseminated intravascular coagulation; ECMO = extracorporeal membrane oxygenation.

ICH: Intracranial hemorrhage

Table III: Fresh Frozen Plasma Transfusion Guidelines

NNF GUIDELINES	AABB GUIDELINES	BCSH GUIDELINES
Indication for Fresh Frozen Plasma Transfusion a. Severe clotting deficiency (including DIC) with bleeding b. Severe clotting deficiency in a neonate undergoing an invasive procedure c. Vitamin K deficiency with bleeding d. Dilutional coagulopathy with bleeding e. Severe anticoagulant protein deficiency f. Reconstitution of packed RBC for exchange transfusion Incorrect Indications: a. Prevention of intraventricular hemorrhage in premature neonates b. Volume replacement in the management of sepsis c. As an adjunct in the management of thrombocytopenia d. To “correct” prolonged indices of coagulation	Fresh Frozen Plasma (FFP) • Support during treatment of disseminated intravascular dissemination. • Replacement therapy: When specific factor concentrates are not available, including, but not limited to antithrombin; protein C or S deficiency; and Factor II, Factor V, Factor X, and Factor XI deficiencies. • During therapeutic plasma exchange when FFP is indicated (cryopoor plasma, plasma from which the cryoprecipitate has been removed). • Reversal of warfarin in an emergency situation, such as before an invasive procedure with active bleeding. Note: FFP is not indicated for volume expansion or enhancement of wound healing.	Recommendations 1. There is no evidence to support the routine use of FFP to try to correct abnormalities of the coagulation screen alone in non-bleeding neonates (1C). 2. FFP may be of benefit in neonates with clinically significant bleeding (including massive blood loss) or prior to invasive procedures with a risk of significant bleeding, and who have an abnormal coagulation profile, defined as a PT or APTT significantly above the normal gestational and postnatal age-related reference range (taking into account local reference ranges where available) (2C). 3. FFP should not be used for simple

		volume replacement or routinely for prevention of IVH (1B).

NNF- NATIONAL NEONATOLOGY FORUM

AABB- AMERICAN ASSOCIATION OF BLOOD BANKS

BCSH- BRITISH COMMITTEE FOR STANDARDS IN HAEMATOLOGY

DOSAGE OF BLOOD AND BLOOD COMPONENTS

TABLE IV - Dosage (AABB)

Component	**Dose**	**Expected Increment**
Red Blood Cells	10-15 mL/kg	Hemoglobin increase 2-3 g/dL*
Fresh Frozen Plasma	10-15 mL/kg	15%-20% rise in factor levels (assuming 100% recovery)
Platelets [whole-bloodderived (WBD) or apheresis]	5-10 mL/kg or 1 WBD unit/10 kg (patients ≥10 kg	50,000/µL rise in platelet count (assuming 100% recovery) †
Cryoprecipitated AHF	1-2 units/10 kg	60-100 mg/dL rise in fibrinogen (assuming 100% recovery)

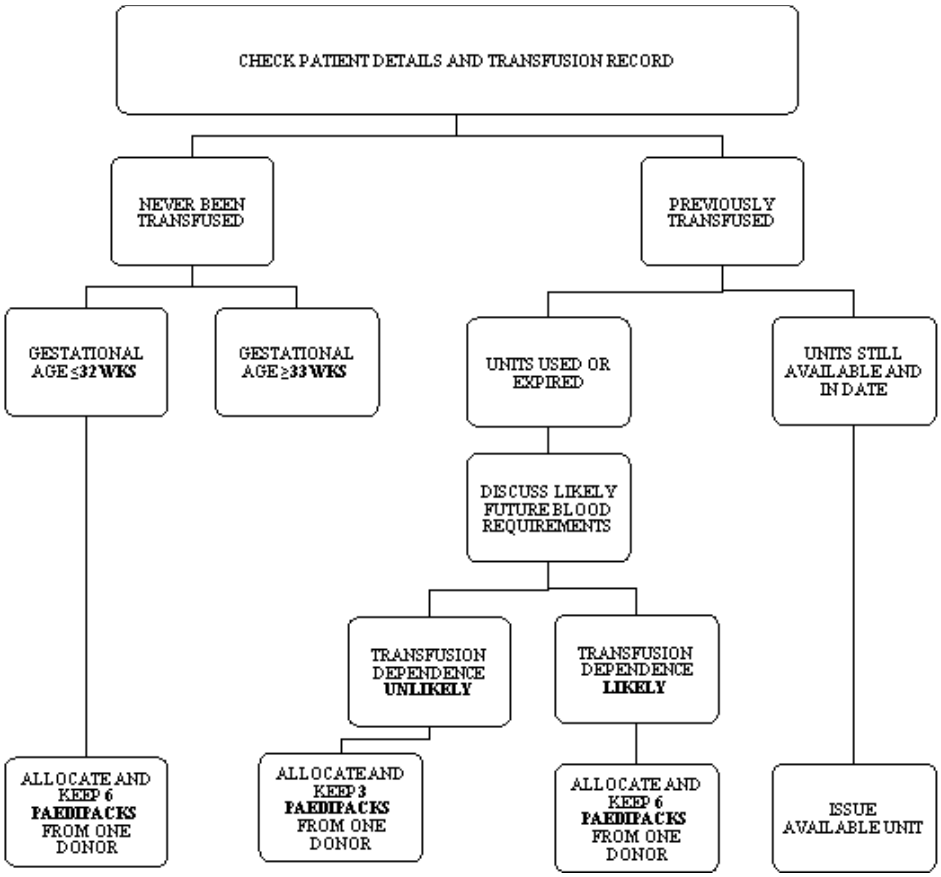
*Dependent on anticoagulant-preservative solution: with 3 g/dL increment forCPD and CPDA-1 and 2 g/dL for AS-1, AS-3 and AS-5.

†Assumes □5.5 × 1010 platelets in 50 mL of plasma (whole-blood-derived)and □3.0 × 1011 platelets in 250-300 mL plasma (apheresis).

CPD = citrate-phosphate-dextrose; CPDA-1 = citrate-phosphate-dextroseadenine- 1; AS = additive solution.

STRATEGIES TO REDUCE DONOR EXPOSURE IN NEONATES

Since blood for multiple transfusions on a given day is typically obtained from one fresh RBC unit, each multiply transfused neonate is exposed to many donors increasing the risk of transfusion transmitted disease[43] Previous studies have recommended reserving 8 satellite packs (SP) for extremely low birth weight (ELBW) babies to reduce donor exposure (DE) from blood transfusions.[1] However, concentration of transfusions at the beginning and end of neonatal care coupled with short shelf-life of blood result in wastage of SPs and unavoidable DE. Neonatal transfusion practice may have changed due to restrictive transfusion guidelines, micro-sampling methoSds and practice of delayed cord clamping. Prasad et al recommend in a study to currently reserve only 4 SPs for ELBW babies and strictly follow British Committee for Standards in Haematology 2004 guidelines for blood transfusion[2,44] In a study by Arora et all, by making multiple aliquots from one bag and reserving for neonates DER of overall transfusion was 1.15 (excluding FFP transfusions) in the study group as compared to 4.03 in the retrospective control group. In study group one donor unit contributed to 1.5 transfusions in each patient and contributed to 50% reduction in DE in each patient as compared to retrospective control group.[45] The other measures to reduce donor exposure are to minimize blood losses by sampling, using cord blood for initial testing, erytheropoietin and delayed cord clamping during birth.


CHECK PATIENT DETAILS AND TRANSFUSION RECORD
NEVER BEEN TRANSFUSED
PREVIOUSLY TRANSFUSED
GESTATIONAL AGE ≤32 WKS
GESTATIONAL AGE ≥33 WKS
UNITS USED OR EXPIRED
UNITS STILL AVAILABLE AND IN DATE
DISCUSS LIKELY FUTURE BLOOD REQUIREMENTS
TRANSFUSION DEPENDENCE UNLIKELY
TRANSFUSION DEPENDENCE LIKELY
ALLOCATE AND KEEP 6 PAEDIPACKS FROM ONE DONOR
ALLOCATE AND KEEP 3 PAEDIPACKS FROM ONE DONOR
ALLOCATE AND KEEP 6 PAEDIPACKS FROM ONE DONOR
ISSUE AVAILABLE UNIT

[46]

FIGURE NO- II - STRATEGIES TO REDUCE DONOR EXPOSURE IN NEONATES

MATERIAL AND METHODS

Study design: Prospective study

Study population: Neonates admitted to the Neonatal Intensive Care Unit (NICU) at DMC&H

Study area:

- NICU & Blood center DMC&H
- Department of Immunohematology and blood transfusion, DMC&H

Sample size and study period:

100 Neonates who were born in the hospital and then admitted for treatment to NICU between April 1, 2021 to march 31, 2022 and fulfill the inclusion criteria were included in the study.

Inclusive Criteria:

- All inborn neonates admitted in NICU who require blood or blood component transfusion during their hospital stay.
- Those who were willing to participate in the study.

Exclusion criteria:

- Neonates with major congenital deformities
- Neonates undergoing surgery.
- The neonates who died within first 24 hours of life.
- Those who did not wish to participate in the study.

Informed consent:

Informed consent from the parents of the neonate was obtained.

Study procedure:

The study protocol was approved by the Ethics Committee of the Institute. A detailed clinical and blood transfusion details were recorded in a predesigned proforma. The data was recorded till the outcome of the baby (Discharge, LAMA, Death). The following variables of the study population were obtained:

- Neonate demographic details such as sex, birth weight, gestational age, number of babies
- APGAR score at 0 and 5 min.
- Hemogram and SpO2 at birth
- Presence of neonatal comorbidities like prematurity, respiratory distress syndrome, neonatal hyperbilirubinemia, necrotizing enterocolitis or congenital malformations.
- Need for ventilation
- Blood grouping and Rh typing
- Indication for transfusion
- Age at first transfusion
- Components requested and issued
- Pre and post transfusion hemogram parameters
- Transfusion related complications
- Outcome

Operational Definitions:

I. Classification of neonates to assess transfusion requirements
    - Gestational age : time from last menstrual period to the birth of the neonate
        1. Very preterm (gestation age ≤ 32 weeks)
        2. Preterm (gestation age >32 weeks to <36 weeks)
        3. Term (gestational age ≥36 weeks)

- Birth weight : weight of the neonate documented within first hour of birth.
    1. Extremely low birth weight (≤1000g)
    2. Very low birth weight (>1000g ≤1500g)
    3. Low birth weight (>1500g ≤2500g)
    4. Normal weight (>2500g)

- Apgar score: Score based on Breathing effort, Heart rate, Muscle tone, Reflexes and Skin color. Calculated

  by adding points in each area. Maximum score is 10

    1. Low (0-3)
    2. Intermediate (4-7)
    3. High (8-10)

Guidelines for PRBC transfusion thresholds in preterm neonates (<32 weeks)

Postnatal age	**Suggested transfusion threshold Hb (g/dL)**		
	Ventilated	On oxygen or CPAP/ NIPPV	No supplemental oxygen
First 24 hr	<12	<12	<10
Days 2 to 7	<12	<10	<10
Days 8 to 14	<10	<9.5	<7.5 – 8.5
Day 15 onwards	<10	<8.5	<7.5

Guidelines for PRBC transfusion thresholds in term neonates

Condition	Hb (g/dL)
Severe pulmonary disease	<12
Moderate pulmonary disease	<10
Severe cardiac disease	<12
Major surgery	<10
Symptomatic anemia	<7

Suggested thresholds for neonatal platelet transfusion

Platelet Count	Condition
<25,000/cubicmm	Neonates with no bleeding (including neonates with NAIT if no bleeding and no family history ofICH)
<50,000 /cubic mm	- Neonates withbleeding - Evidence ofcoagulopathy - Beforesurgery - NAIT if previously affected sibling withICH
<1,00,000 /cubic mm	Major bleeding e.g. significant IVH Major surgery

NAIT, neonatal alloimmune thrombocytopenia; ICH, intracranial hemorrhage. Adapted with permission from British Committee for Standards in Hematology: Guidelines on transfusion for fetuses, neonates and older children 2016.

Pediatric dosing of blood components

Component	Dose	Expected increment
Red Blood Cells Fresh Frozen Plasma	10-15 mL/kg 10-15 mL/kg	Hemoglobinincrease 2-3g/dL 15%-20% rise in factor levels (assuming 100% recovery)
Platelets (whole-blood-derived (WBD) or apheresis)	5-10 mL/kgor 1 WBDunit/10 kg(patients <10 kg)	50,000/µL riseinplatelet count (assuming 100% recovery)

OBSERVATION AND RESULTS

DEMOGRAPHIC CHARACTERISTICS OF NEONATES

1) SEX

In the study population (n=100), 37% (n=37) were females and 63% (n=63) were males.

Table 1.1 SEX

SEX	No. of cases	Percentage
F	37	37.0%
M	63	63.0%
Total	100	100.0%

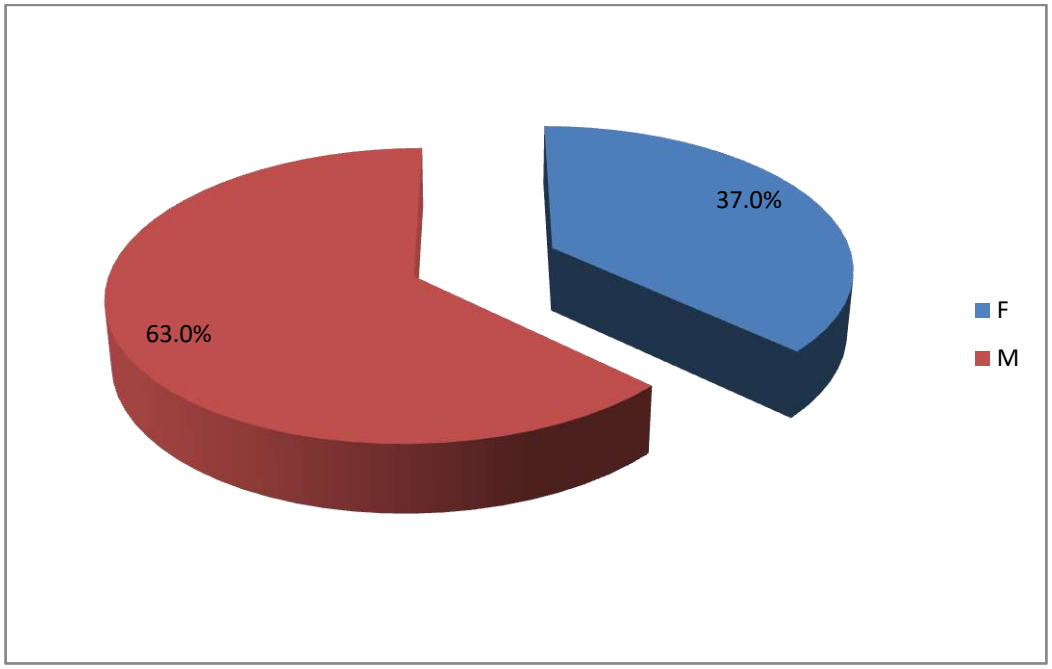


Figure 1.1 SEX

2) AGE OF GESTATION

In the study population (n=100), 32% (n=32) were very preterm (≤ 32 weeks), 36% (n=36) were preterm (>32 weeks to <36 weeks) and 32% (n=32) were term babies (≥36 weeks). Depending on the gestational age the population was divided into 3 groups described in Table 2.

Table 2.1 AGE OF GESTATION

GROUP	Gestation (weeks)	No. of cases	Percentage
Group I	≤ 32	32	32.0%
Group II	>32 to <36	36	36.0%
Group III	≥ 36	32	32.0%
	Total	100	100.0%

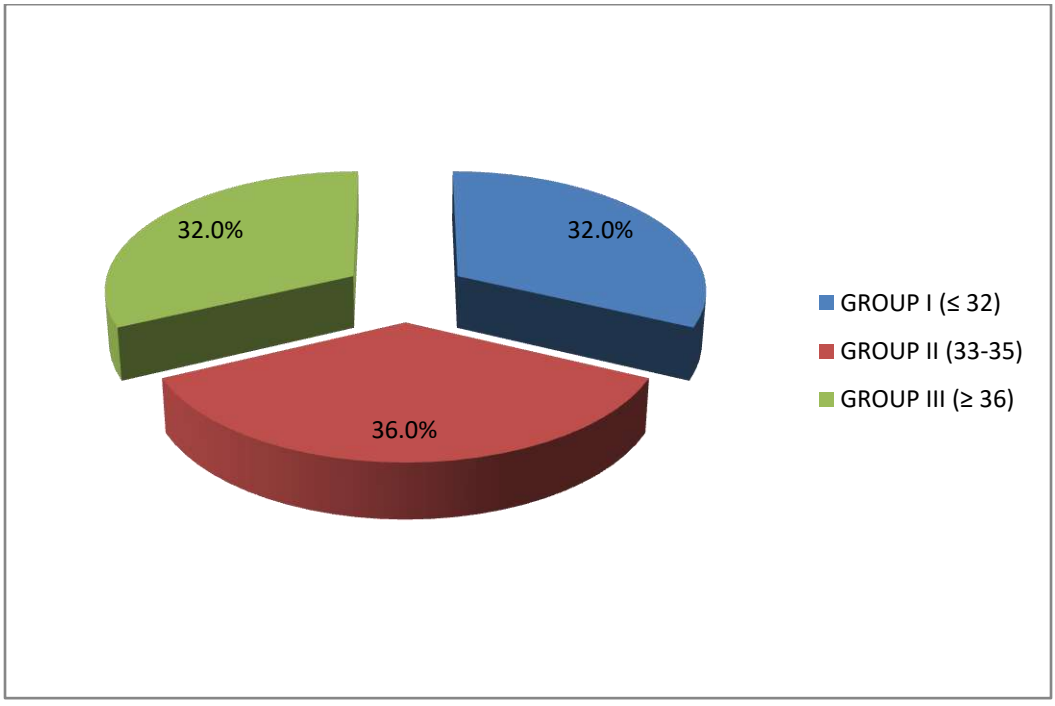


Figure 2.1 AGE OF GESTATION

In group I (n=32), 31.3% were females and 68.8% were males. In Group II (n=36), 41.7% were females and 58.3% were males. In group III(n=36), 37.5% were females and 62.5% were males. P value was 0.672 so no significance found.

Table 2.2 AGE OF GESTATION

		Gestation						Total	Chi-square value	p-value
		GROUP I		GROUP II		GROUP III				
SEX	F	10	31.3%	15	41.7%	12	37.5%	37	0.794	0.672
	M	22	68.8%	21	58.3%	20	62.5%	63		
Total		32	100.0 %	36	100.0%	32	100.0 %	100		

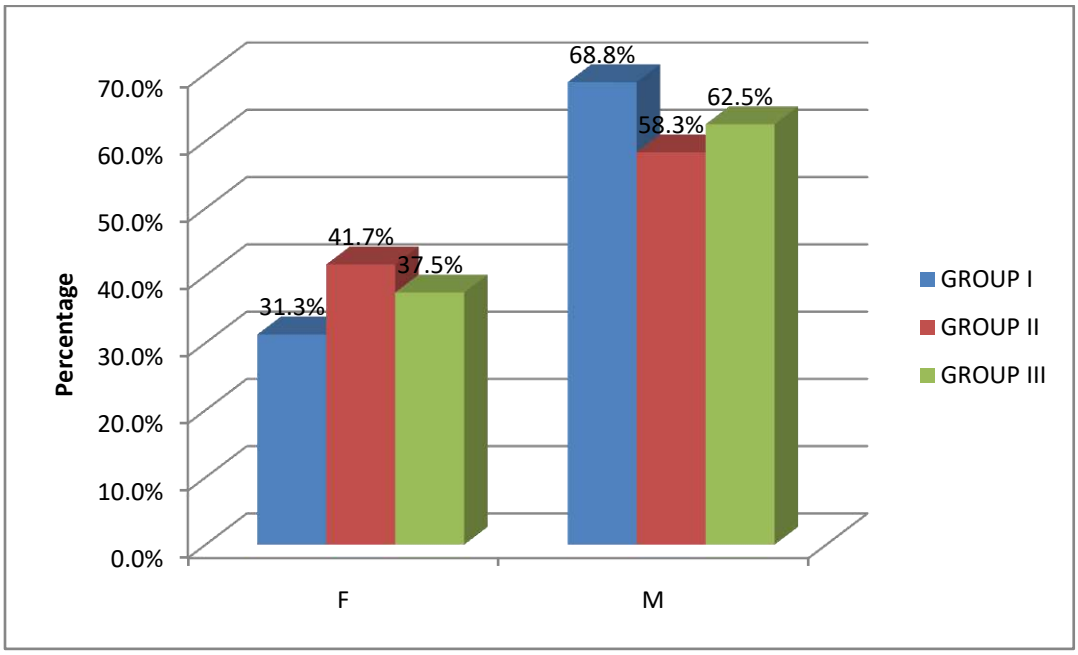


FIGURE 2.2 AGE OF GESTATION

3) DISTRIBUTION OF BABY BLOOD GROUP

In the study population (n=100), 1%(n=1) was A Negative, 28% (n=28) were A Positive, 7% (n=7) were AB Positive, 3% (n=3) were B Negative, 23% (n=23) were B Positive, 3% (n=3) were O Negative and 35% (n=35) were O Positive

Table 3.1 BABY BLOOD GROUP

BABY BG	No. of cases	Percentage
A-	1	1.0%
A+	28	28.0%
AB+	7	7.0%
B-	3	3.0%
B+	23	23.0%
O-	3	3.0%
O+	35	35.0%
Total	100	100.0%

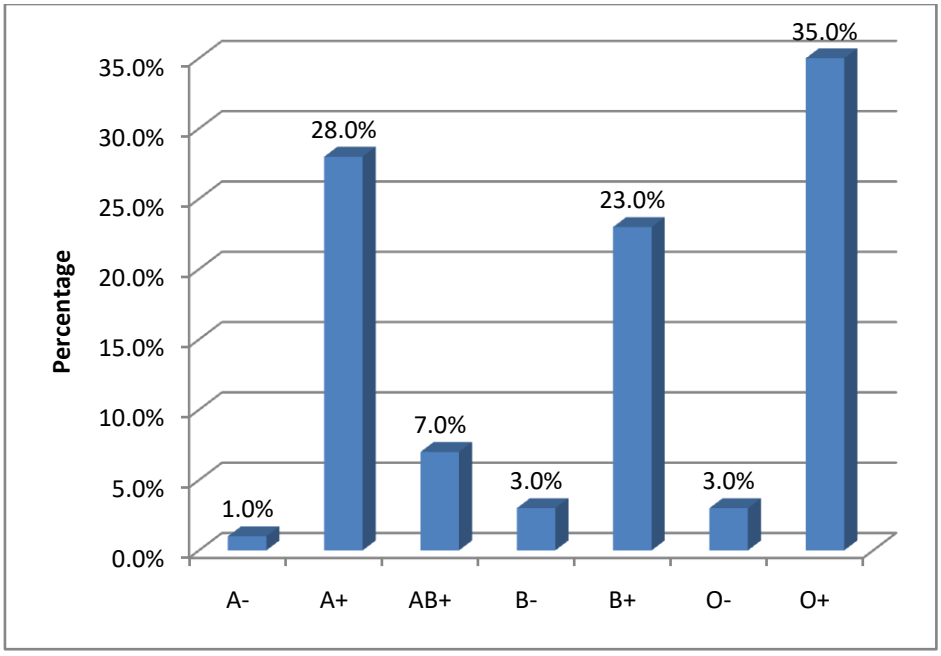


Figure 3.1 BABY BLOOD GROUP

4) BIRTH WEIGHT

In the study population (n=100), 15% (n=15) were ELBW (Extremely low birth weight, weight<1000g), 25% (n=25) were VLBW (Very low birth weight, weight>1000g and < 1500g), 32% (n=32) were LBW (Low birth weight, weight>1500g and <2500g) and 28% (n=28) were NW (Normal birth weight, weight> 2500g).

TABLE 4.1 BIRTH WEIGHT

	BIRTH WEIGHT	No. of cases	Percentage
1	ELBW (<1000g)	15	15.0%
2	VLBW(>1000g<1500g)	25	25.0%
3	LBW(>1500g<2500g)	32	32.0%
4	NW(>2500g)	28	28.0%
	Total	100	100.0%

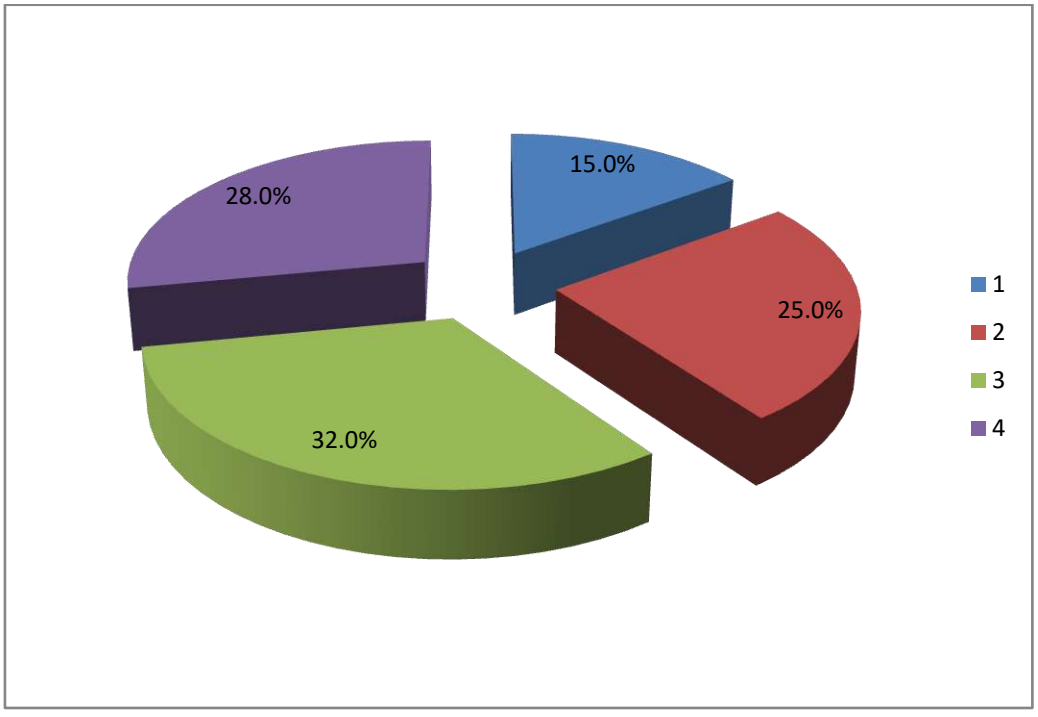


FIGURE 4.1 BIRTH WEIGHT

In group I (n=32), 46.9% were extremely low birth weight and 53.1% were very low birth weight.

In Group II (n=36), 22.2% were very low birth weight, 72.2% were low birth weight and 5.6% were normal birth weight.

In Group III (n=32), 18.8% were low birth weight and 81.3% were normal birth weight.

P value for birth weight was 0.0001 making it significant.

TABLE 4.2 BIRTH WEIGHT

		Gestation						Total	Chi-square value	p-value
		GROUP I		GROUP II		GROUP III				
BIRTH WEIGHT GROUP	1	15	46.90 %	0	0.00 %	0	0.00 %	15	128.15	0.0001
	2	17	53.10 %	8	22.20 %	0	0.00 %	25		
	3	0	0.00 %	26	72.20 %	6	18.80 %	32		
	4	0	0.00 %	2	5.60 %	26	81.30 %	28		
Total		32		36		32		100		

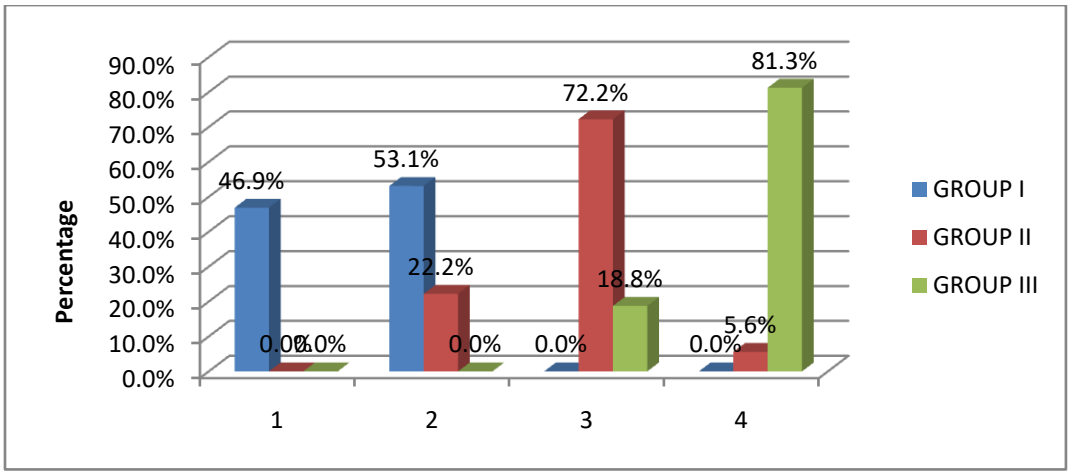


FIGURE 4.2 BIRTH WEIGHT

5) APGAR SCORE

Apgar score at 0 and 5 minutes was observed. Neonates were divided into 3 categories depending on Low, intermediate and high Apgar score.

TABLE 5.1 APGAR SCORE (0 MINUTES)

APGAR (0min)	No. of cases	Percentage
LOW (0-3)	1	1.0%
INTERMEDIATE(4-7)	66	66.0%
HIGH(8-10)	36	36.0%
Total	100	100.0%

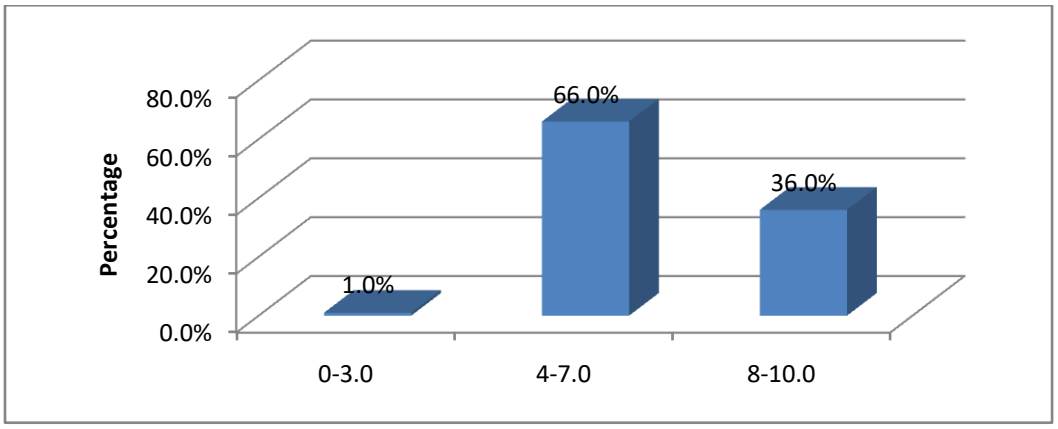


FIGURE 5.1 APGAR SCORE (0 MINUTES)

TABLE 5.2 APGAR SCORE (5 MINUTES)

APGAR (5min)	No. of cases	Percentage
LOW (0-3)	0	0.0%
INTERMEDIATE (4-7)	28	28.0%
HIGH (8-10)	72	72.0%
Total	100	100.0%

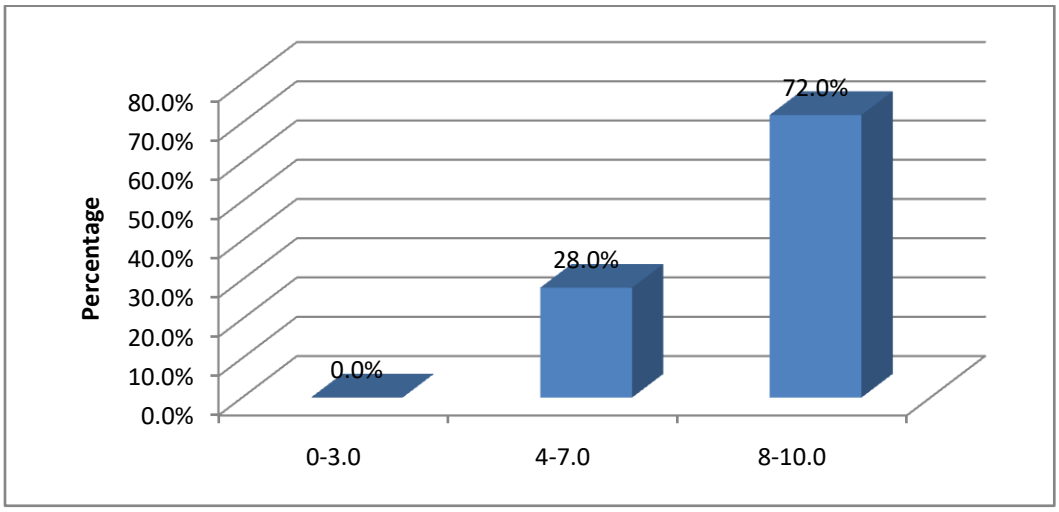


FIGURE 5.2 APGAR SCORE(5 MINUTES)

6) SINGLETON AND MULTIPLE GESTATION

In the study population (n=100), 81% (n=81) were single babies, 11% (n=11) were twins and 8% (n=8) were triplets.

TABLE 6.1 SINGLETON AND MULTIPLE GESTATION

Neonate	No. of cases	Percentage
Singleton (1)	81	81.0%
Twins (2)	11	11.0%
Triplets (3)	8	8.0%
Total	100	100.0%

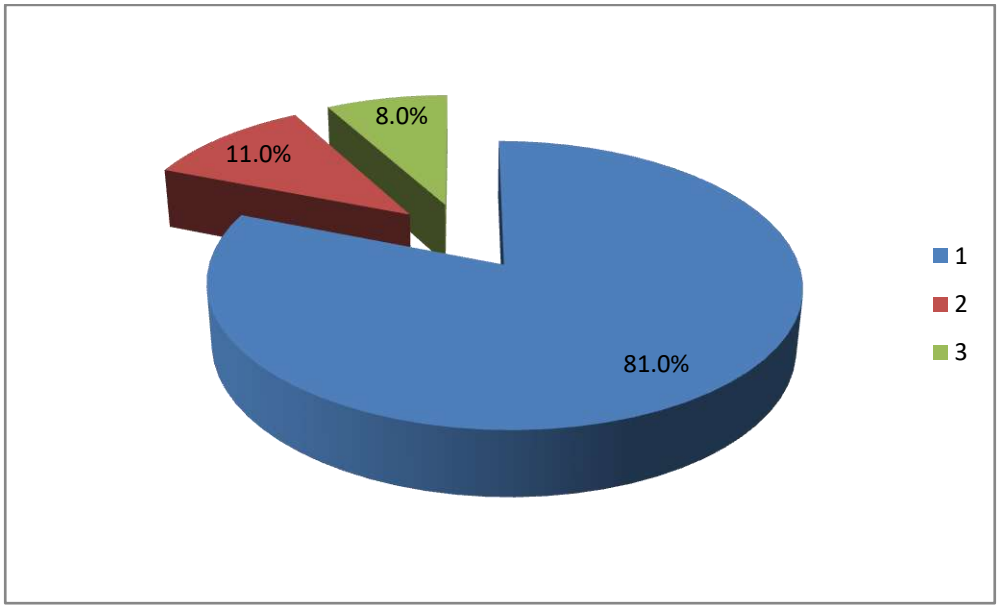


FIGURE 6.1 SINGLETON AND MULTIPLE GESTATION

7) NEONATE FACTORS AT BIRTH

7.1) PREMATURITY

In the study population (n=100), 68% were premature.

TABLE 7.1 PREMATURITY

PREMATURITY	No. of cases	Percentage
N	32	32.0%
Y	68	68.0%
Total	100	100.0%

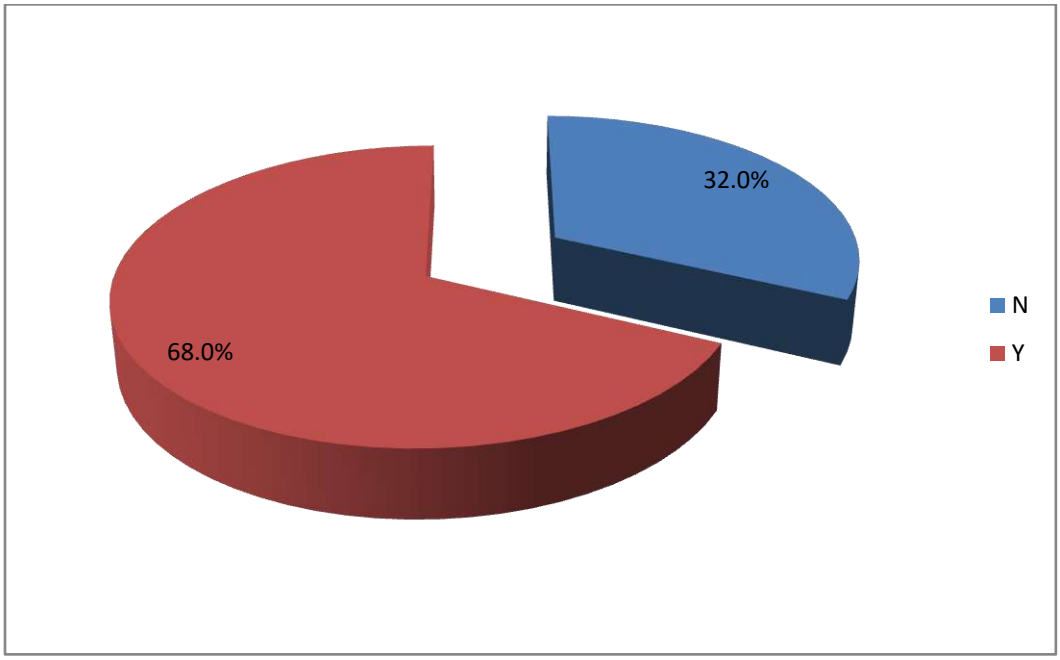


FIGURE 7.1 PREMATURITY

7.2) RESPIRATORY DISTRESS SYNDROME

In the study population (n=100), 55% had Respiratory Distress at birth.

TABLE 7.2 RESPIRATORY DISTRESS SYNDROME

RDS	No. of cases	Percentage
N	45	45.0%
Y	55	55.0%
Total	100	100.0%

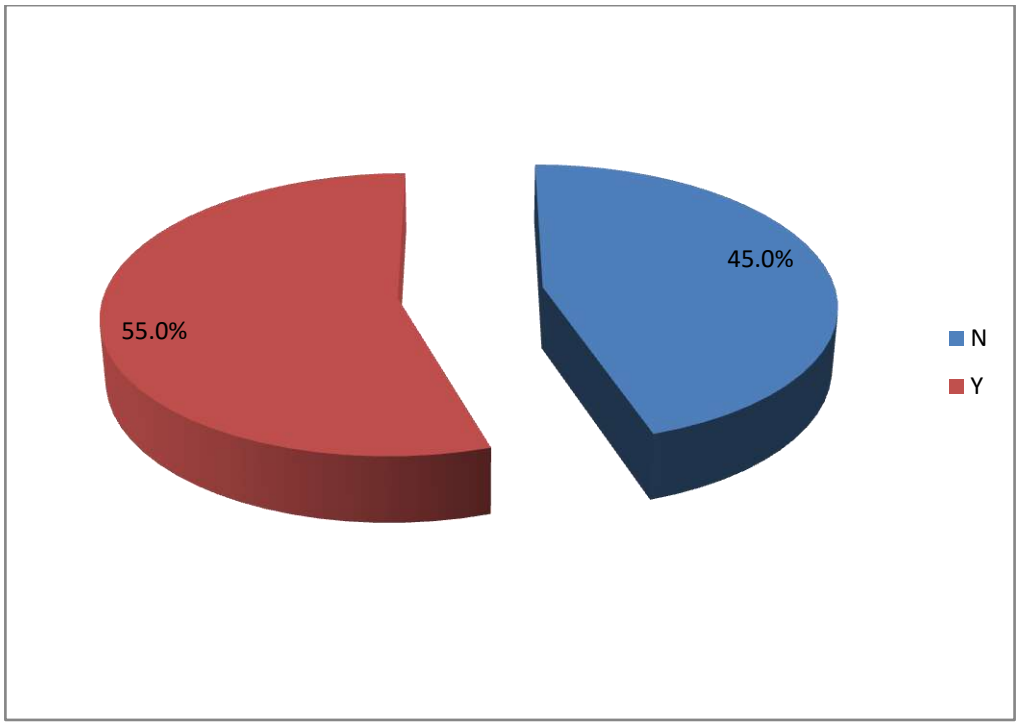


FIGURE 7.2 RESPIRATORY DISTRESS SYNDROME

7.3) NEONATAL HYPERBILIRUBINEMIA

In the study population (n=100), 36% had neonatal hyperbilirubinemia.

TABLE 7.3 NEONATAL HYPERBILIRUBINEMIA

Neonatal Hyperbilirubinemia.	No. of cases	Percentage
N	64	64.0%
Y	36	36.0%
Total	100	100.0%

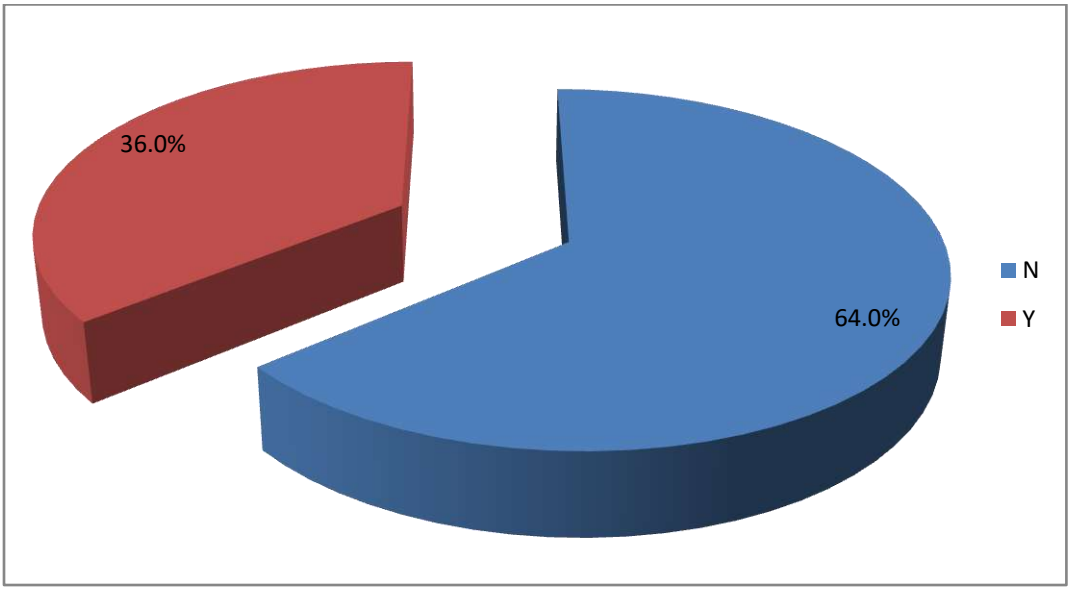


FIGURE 7.3 NEONATAL HYPERBILIRUBINEMIA

7.4) NECROTISING ENTEROCOLITIS

In the study population (n=100), 6% were born with necrotizing enterocolitis.

TABLE 7.4 NECROTISING ENTEROCOLITIS

NECROTISING ENTEROCOLITIS	No. of cases	Percentage
N	94	94.0%
Y	6	6.0%
Total	100	100.0%

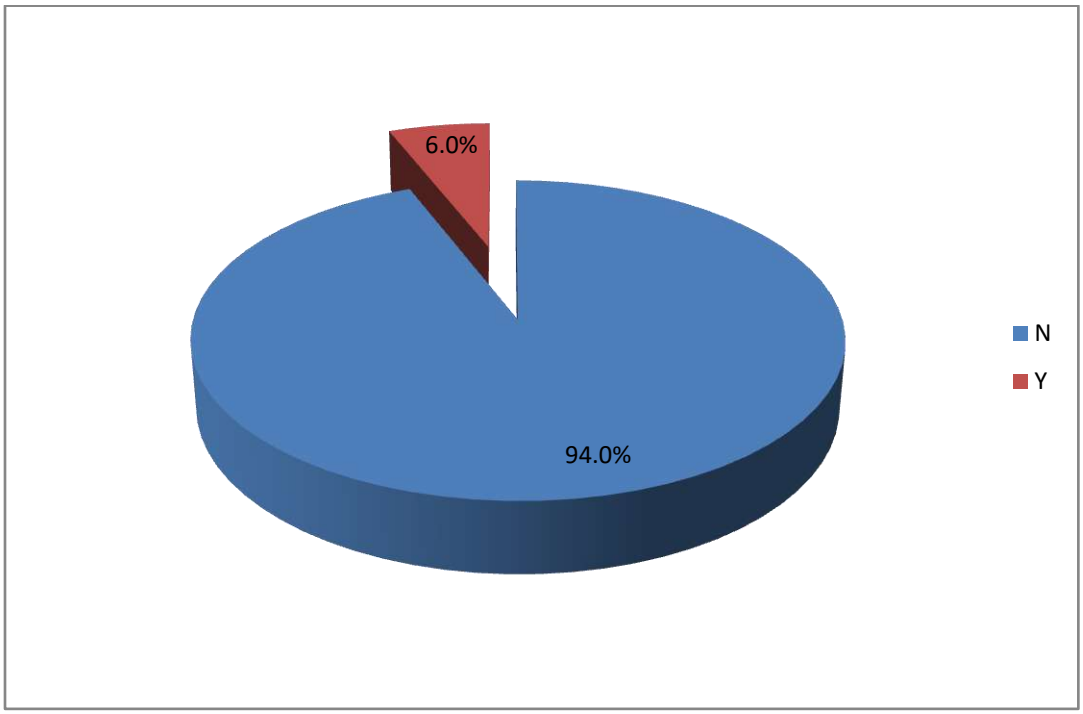


FIGURE 7.4 NECROTISING ENTEROCOLITIS

7.5) CONGENITAL MALFORMATION

In the study population (n=100), 1% had Down's syndrome

TABLE 7.5 CONGENITAL MALFORMATIONS

CONGENITAL MALFORMATIONS	No. of cases	Percentage
DOWNS	1	1.0%
N	99	99.0%
Total	100	100.0%

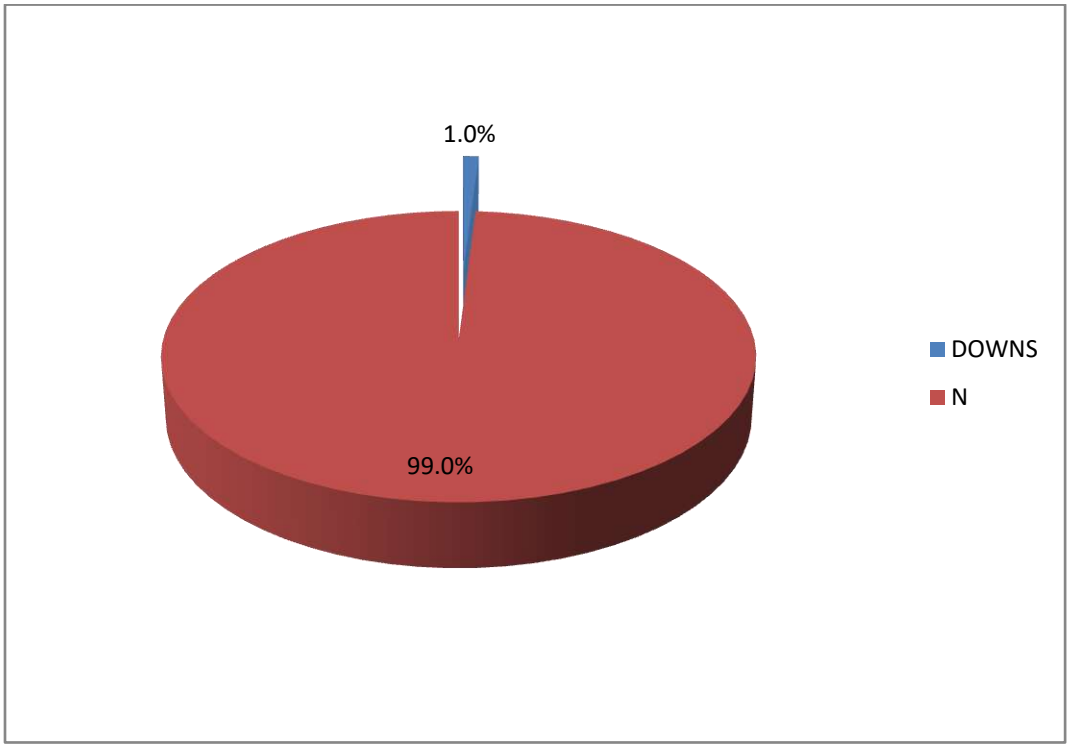


FIGURE 7.5 CONGENITAL MALFORMATIONS

7.6) OTHER CONGENITAL MALFORMATION

One neonate had ACHD and one neonate had hydropsfoetalis. This data is depicted in the table and the figure below.

TABLE 7.6 OTHER CONGENITAL MALFORMATION

OTHER	No. of cases	Percentage
ACHD	1	1.0%
HYDROPS FOETALIS	1	1.0%
N	98	98.0%
Total	100	100.0%

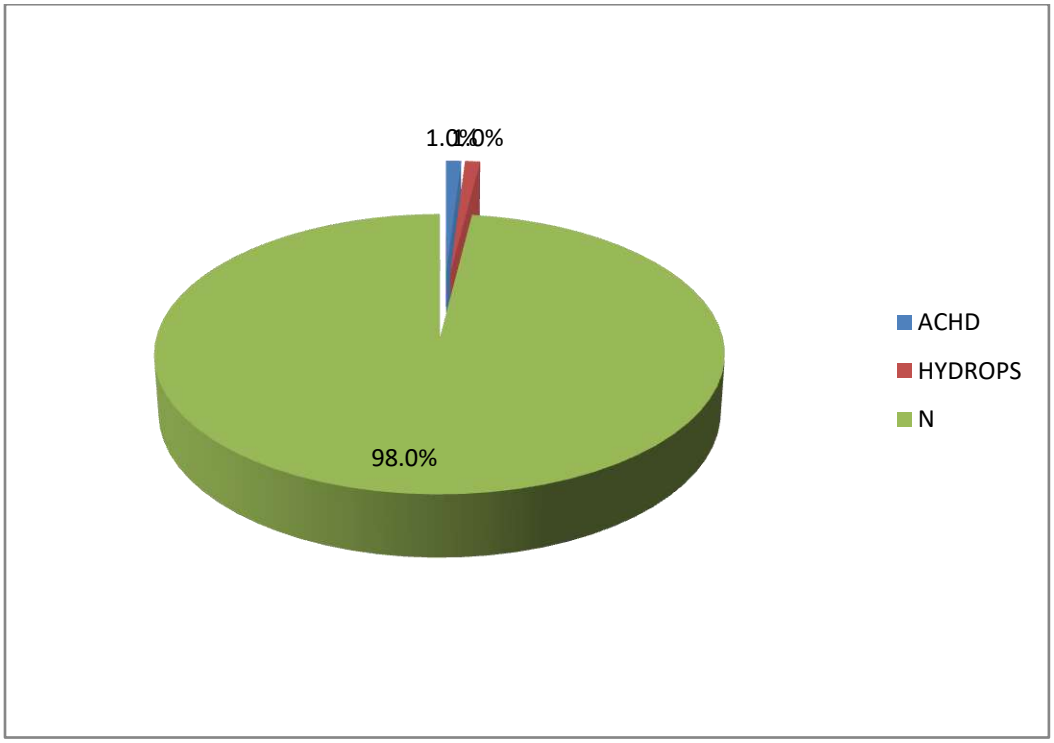


FIGURE 7.6 OTHER CONGENITAL MALFORMATION

7.7) GROUP WISE DISTRIBUTION OF NEONATAL COMORBIDITIES

In group I (n=32), 100% neonates had respiratory distress syndrome, 37.5% had neonatal hyperbilirubinemia, 12.5% had necrotizing enterocolitis and 3.1% had acyanotic heart disease.

In group II (n=36), 63.9% had Respiratory distress syndrome, 44.4% had neonatal hyperbilirubinemia, 2.8% had necrotizing enterocolitis.

In Group III (n=32), 25% had neonatal hyperbilirubinemia, 3.1% had necrotizing enterocolitis.

Table 7.7 NEONATAL COMORBIDITIES

		Gestation						Total	Chi-square value	p-value
		GROUP I		GROUP II		GROUP III				
RDS	N	0	0.0%	13	36.1%	32	100.0%	45	66.442	0.001
	Y	32	100.0%	23	63.9%	0	0.0%	55		
NEONATAL HYPERBILIRUBINEMIA	N	20	62.5%	20	55.6%	24	75.0%	64	2.826	0.243
	Y	12	37.5%	16	44.4%	8	25.0%	36		
NECROTISING ENTEROCOLITIS	N	28	87.5%	35	97.2%	31	96.9%	94	3.526	0.171
	Y	4	12.5%	1	2.8%	1	3.1%	6		
CONGENITAL MALFORMATION	DOWNS	0	0.0%	0	0.0%	1	3.1%	1	2.146	0.342
	N	32	100.0%	36	100.0%	31	96.9%	99		
OTHER	ACHD	1	3.1%	0	0.0%	0	0.0%	1	3.922	0.417
	HYDROPS	0	0.0%	1	2.8%	0	0.0%	1		
	N	31	96.9%	35	97.2%	32	100.0%	98		

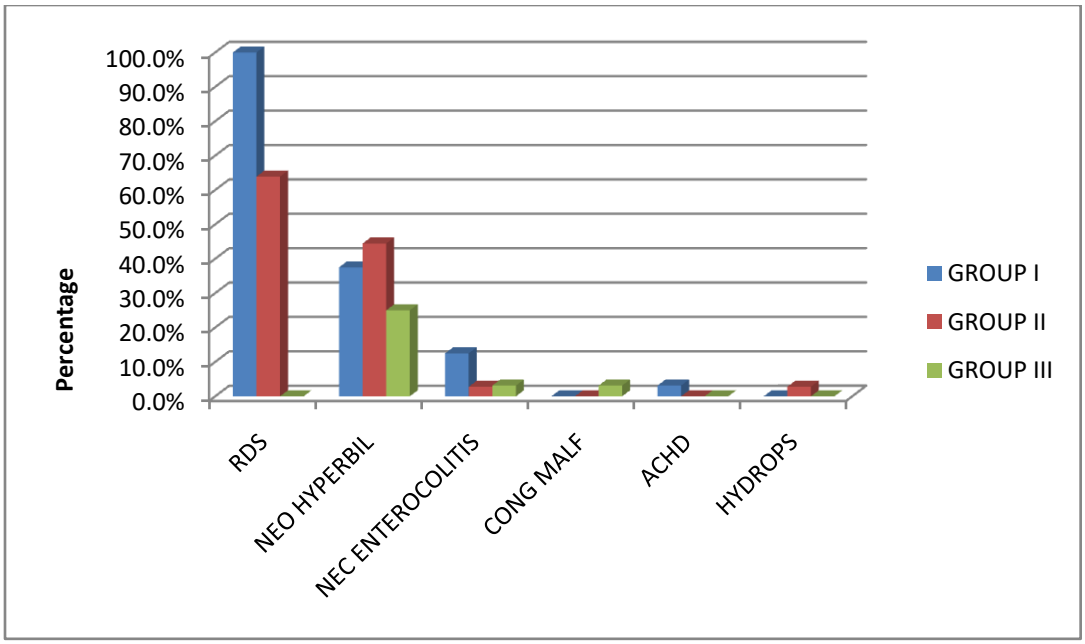


Figure 7.7 NEONATAL COMORBIDITIES

8) RESPIRATORY SUPPORT

8.1) In the study population (n=100), 49% patients required mechanical ventilation, 48% needed CPAP, 34% needed Nasal cannula, 25% needed nasal oxygen prongs and 26% didn't need any respiratory support during hospital stay.The table and graph below shows trends for need for respiratory support in each group.

Table 8.1 RESPIRATORY SUPPORT

RESPIRATORY SUPPORT	NO. OF CASES
MV	49
CPAP	48
NC	34
NOP	25
NONE	26

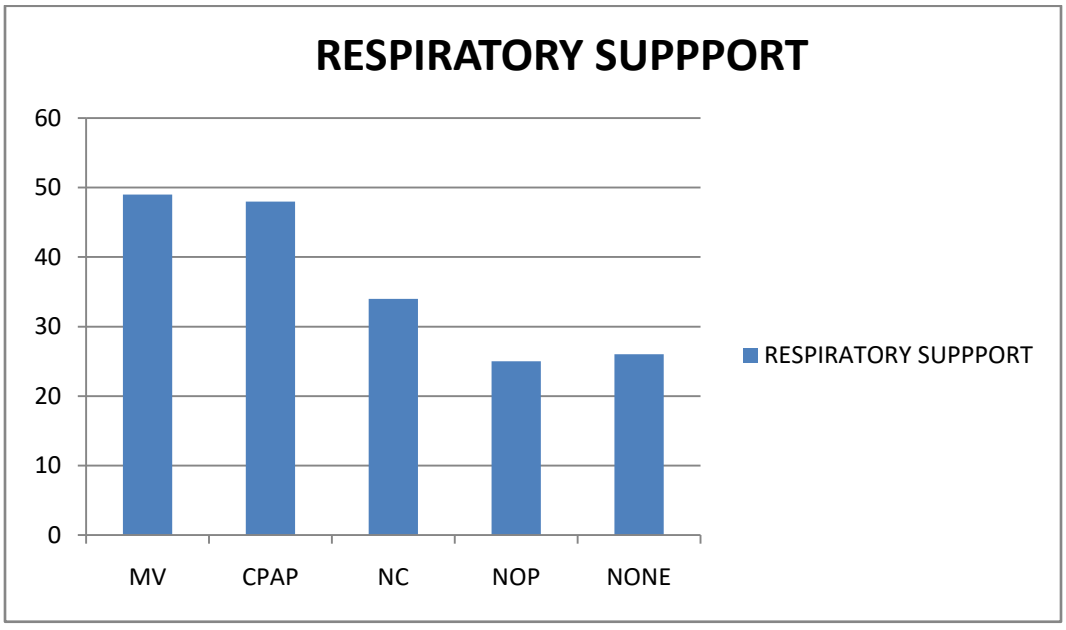


FIGURE 8.1 RESPIRATORY SUPPORT

8.2) Respiratory support according to gestation age is demonstrated in the table and graph below.

Table 8.2RESPIRATORY SUPPORT

		Gestation						Total	Chi-e value	p-value
		GROUP I		GROUP II		GROUP III				
M.V	N	1	3.1%	20	55.6%	30	93.8%	51	53.051	0.001
	Y	31	96.9%	16	44.4%	2	6.3%	49		
CPAP	N	10	31.3%	13	36.1%	29	90.6%	52	28.288	0.001
	Y	22	68.8%	23	63.9%	3	9.4%	48		
N.C	N	22	68.8%	16	44.4%	28	87.5%	66	14.154	0.001
	Y	10	31.3%	20	55.6%	4	12.5%	34		
N.O.P	N	27	84.4%	24	66.7%	24	75.0%	75	2.833	0.243
	Y	5	15.6%	12	33.3%	8	25.0%	25		
NONE	N	32	100.0%	30	83.3%	12	37.5%	74	35.031	0.001
	Y	0	0.0%	6	16.7%	20	62.5%	26		
Total		32	100.0%	36	100.0%	32	100.0%	100		

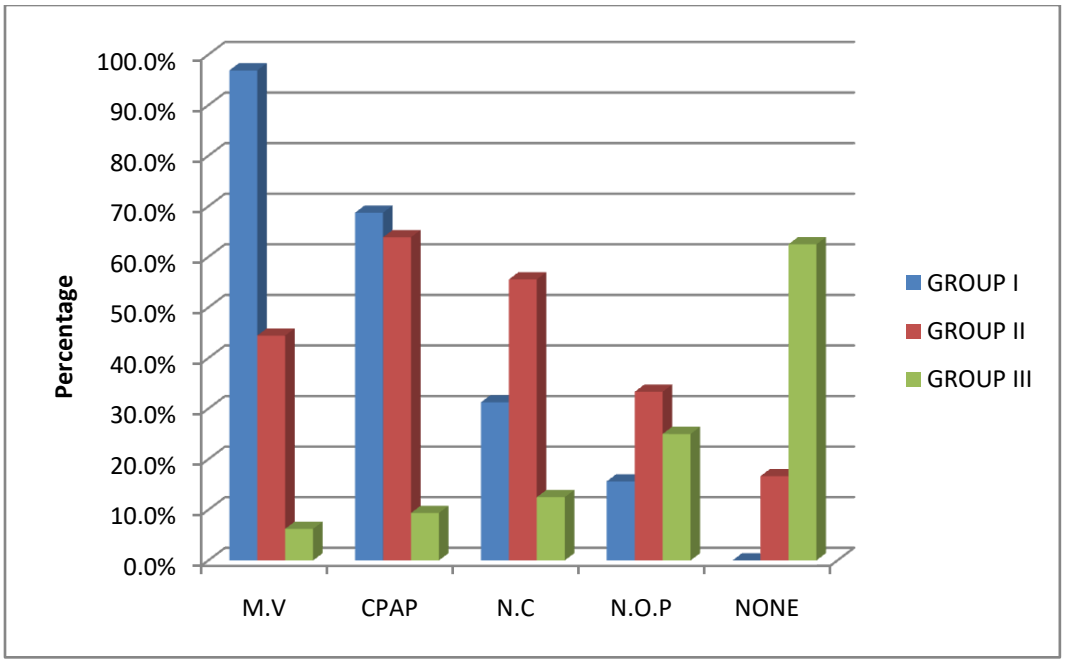


FIGURE 8.2 RESPIRATORY SUPPORT

8.3) TREND OF CHANGE IN RESPIRATORY SUPPORT.

The trend of change of the type of respiratory support of 28 subjects who required respiratory support during hospital stay is depicted in the table and graph below.

M stands for mechanical ventilation, c stands for CPAP, N stands for nasal cannula and NOP stands for nasal oxygen prongs.

TABLE 8.3 TREND OF CHANGE IN RESPIRATORY SUPPORT

M-C-N-NOP	No. of cases	Percentage
	28	28.0%
C	3	3.0%
C-N	2	2.0%
C-N-NOP	3	3.0%
C-NC	1	1.0%
C-NC-NOP	2	2.0%
C-NOP	2	2.0%
M	13	13.0%
M-C	7	7.0%
M-C--N-C-NOP	1	1.0%
M-C-M	4	4.0%
M-C-M-C	1	1.0%
M-C-M-C-N	2	2.0%
M-C-M-C-NC	1	1.0%
M-C-M-NC	1	1.0%
M-C-M-NC-NOP	1	1.0%
M-C-M-NOP	1	1.0%
M-C-N	1	1.0%
M-C-N-C-N	1	1.0%
M-C-N-C-NOP	1	1.0%
M-C-N-NOP-N-NOP	1	1.0%
M-C-NC	7	7.0%
M-C-NC-M-C	1	1.0%
M-C-NC-NOP	1	1.0%
M-C-NC-NOP-C	1	1.0%
M-C-NOP	2	2.0%
M-C-NOP-C-NOP	1	1.0%
N-NOP	1	1.0%
N-NOP-N	1	1.0%
NC	1	1.0%
NOP	7	7.0%
Total	100	100.0%

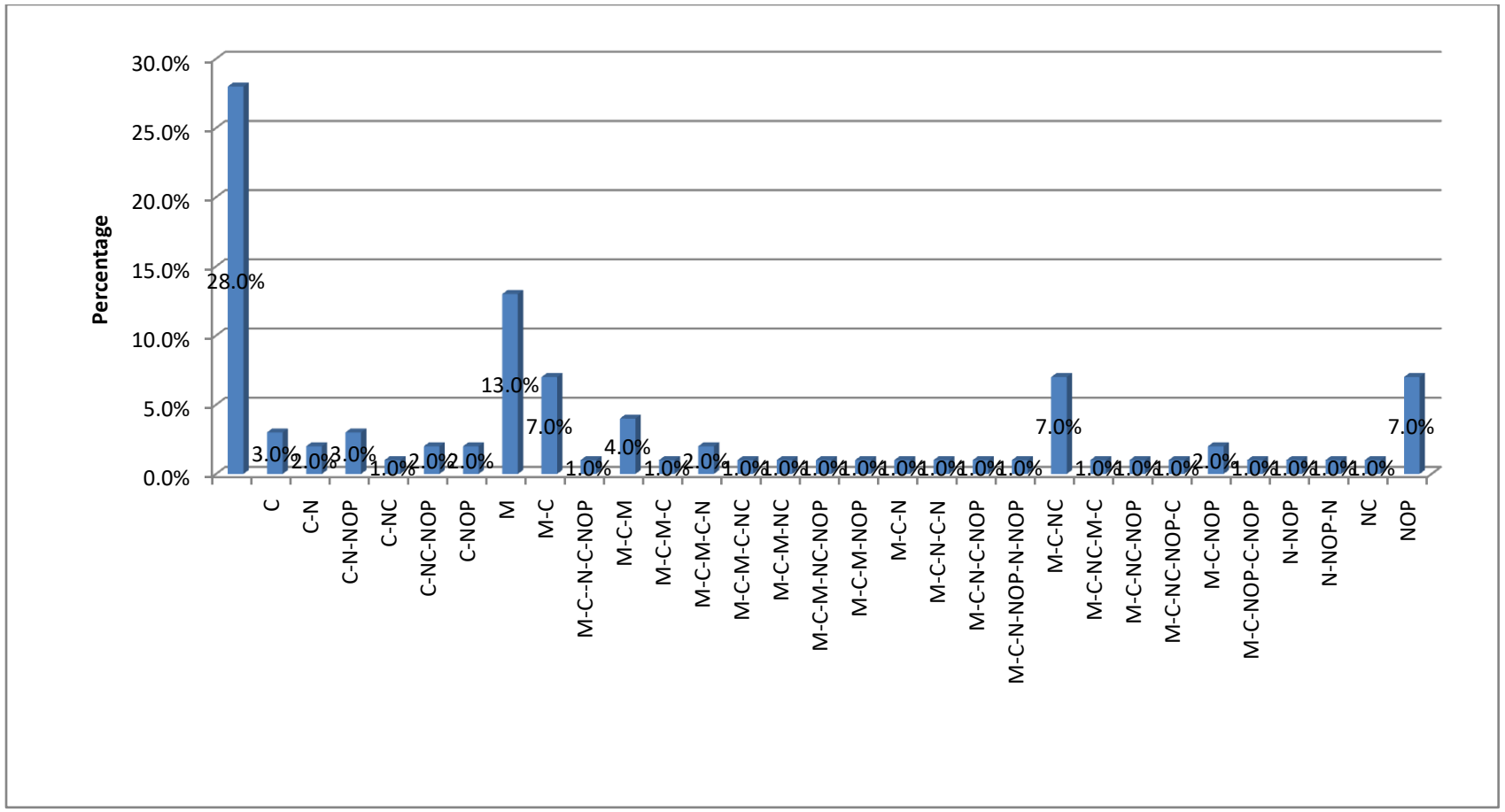


FIGURE 8.3 TREND OF CHANGE IN RESPIRATORY SUPPORT

9) AGE ON THE DAY OF 1ST TRANSFUSION

Neonates were categorized into 4 categories depending on the age of the neonate when 1st transfusion was given.43% neonates received 1st transfusion in the first week of life, 25% neonates received 1st transfusion in the second week of life, 17% neonates received 1st transfusion in the third week of life15% neonates received 1st transfusion in the fourth week of life.

TABLE 9.1AGE ON THE DAY OF 1ST TRANSFUSION

AGE on 1st transfusion (d)	No. of cases	Percentage
0-7	43	43.0%
8-14	25	25.0%
15-21	17	17.0%
22-28	15	15.0%

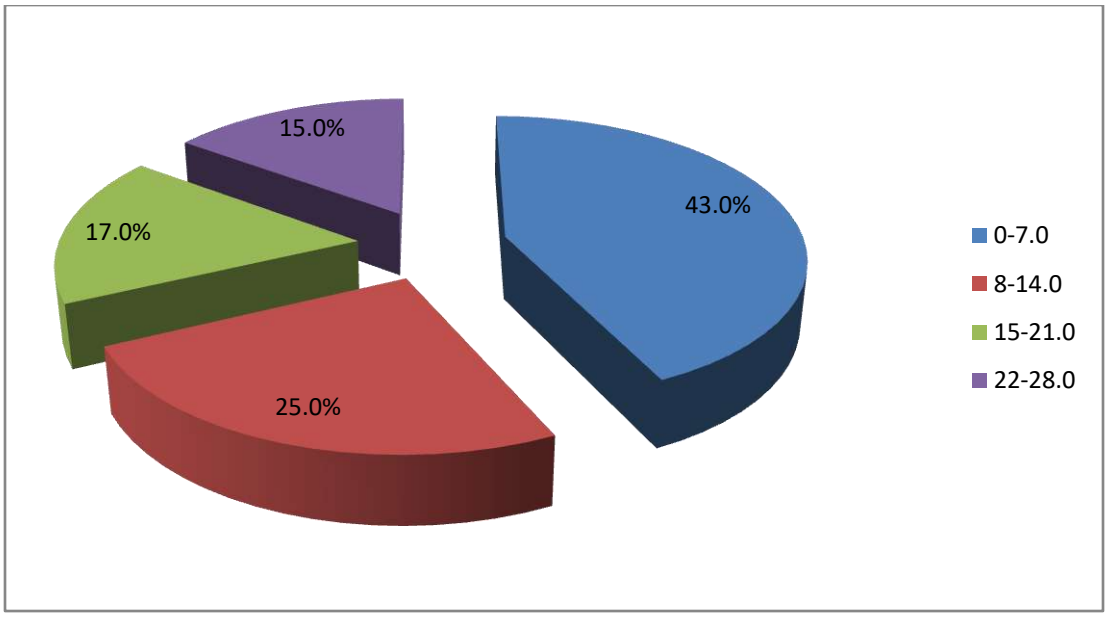


FIGURE 9.1 AGE ON THE DAY OF 1ST TRANSFUSION

10) INDICATIONS OF TRANSFUSION

In group I the indication for transfusion in 71.9% (n=23) was low Hemoglobin, in 53.1% (n=17) was shock with sepsis, in 37.5% (n=12) was low SpO2, in 50% (n=16) was bleeding, in 53.1% (n=17) was thrombocytopenia, in 3.1% (n=1) was surgery, in 18.8% (n=6) was coagulopathy, in 6.3% (n=2) was high bilirubin, in 3.1% (n=1) was Rh incompatibility.

In group II indication for transfusion in 69.4% (n=25) was low Hemoglobin, in 33.3% (n=12) was shock with sepsis, in 13.9% (n=5) was low SpO2, in 38.9% (n=14) was bleeding, in 41.7% (n=15) was thrombocytopenia, in 5.6% (n=2) was coagulopathy, in 5.6% (n=2) was high bilirubin, in 5.6%(n=2) was Cardiopulmonary syndrome.

In group III indication for transfusion in 46.9% (n=15) was low Hemoglobin, in 31.3% (n=10) was shock with sepsis, in 3.1% (n=1) was low SpO2, in 31.3% (n=10) was bleeding, in 43.8% (n=14) was thrombocytopenia, in 21.9% (n=7) was coagulopathy, in 9.4%(n=3) was high bilirubin, in 6.3% (n=2) was Rh incompatibility.

This is depicted in the table and chart ahead:

TABLE 10- INDICATIONS OF TRANSFUSION

		Gestation						Total	Chi-square value	p-value
		GROUP I		GROUP II		GROUP III				
LOW Hb	N	9	28.1%	11	30.6%	17	53.1%	37	5.292	0.071
	Y	23	71.9%	25	69.4%	15	46.9%	63		
S . S	N	15	46.9%	24	66.7%	22	68.8%	61	3.978	0.137
	Y	17	53.1%	12	33.3%	10	31.3%	39		
LOW SPO2	N	20	62.5%	31	86.1%	31	96.9%	82	13.453	0.001
	Y	12	37.5%	5	13.9%	1	3.1%	18		
BLEED	N	16	50.0%	22	61.1%	22	68.8%	60	2.373	0.305
	Y	16	50.0%	14	38.9%	10	31.3%	40		
T. PENIA	N	15	46.9%	21	58.3%	18	56.3%	54	0.991	0.609
	Y	17	53.1%	15	41.7%	14	43.8%	46		
SURGERY	N	31	96.9%	36	100.0%	32	100.0%	99	2.146	0.342
	Y	1	3.1%	0	0.0%	0	0.0%	1		
COAGULOPATHY	N	26	81.3%	34	94.4%	25	78.1%	85	4.058	0.131
	Y	6	18.8%	2	5.6%	7	21.9%	15		
ENZYME DEFICIENCY	N	32	100.0%	36	100.0%	32	100.0%	100		
HIGH BILIRUBIN	N	30	93.8%	34	94.4%	29	90.6%	93	0.420	0.810
	Y	2	6.3%	2	5.6%	3	9.4%	7		
CPS	N	32	100.0%	34	94.4%	32	100.0%	98	3.628	0.163
	Y	0	0.0%	2	5.6%	0	0.0%	2		
Rh INCOMP	N	31	96.9%	36	100.0%	30	93.8%	97	2.277	0.320
	Y	1	3.1%	0	0.0%	2	6.3%	3		
OTHER	N	32	100.0%	36	100.0%	32	100.0%	100		
Total		32	100.0%	36	100.0%	32	100.0%	100		

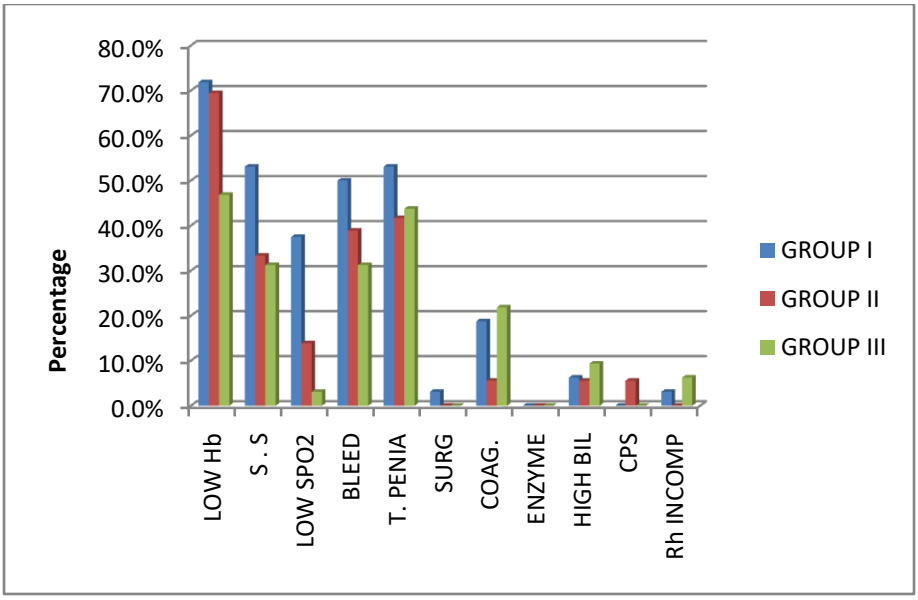


FIGURE 10- INDICATIONS OF TRANSFUSION

11) PATTERN OF PRBC TRANSFUSION

In the study population (n=100), 75 received PRBC transfusions.

In group I, 27 received PRBC transfusion. 48.1% (n=13) received single unit PRBC. 33.3% (n=9) received 2 units PRBC. 14.8% (n=4) received 3 units PRBC and 3.7% (n=1) received 5 units PRBC.

In group II 28 received PRBC transfusion. 57.1% (n=16) received single unit PRBC. 28.6% (n=8) received 2 units PRBC. 10.7% (n=3) received 3 units PRBC and 3.6% (n=1) received 4 units PRBC.

In Group III 20 received PRBC transfusion. 85% (n=17) received 1 unit PRBC and 15% (n=3) received 2 units PRBC.

The table and figure ahead depict this

TABLE 11 PATTERN OF PRBC TRANSFUSION

		Gestation						Total	Chi-square value	p-value
		GROUP I		GROUP II		GROUP III				
PRBC	1	13	48.1%	16	57.1%	17	85.0%	46	10.43	0.23
	2	9	33.3%	8	28.6%	3	15.0%	20		
	3	4	14.8%	3	10.7%	0	0.0%	7		
	4	0	0.0%	1	3.6%	0	0.0%	1		
	5	1	3.7%	0	0.0%	0	0.0%	1		
Total		27	100.0%	28	100.0%	20	100.0%	75		

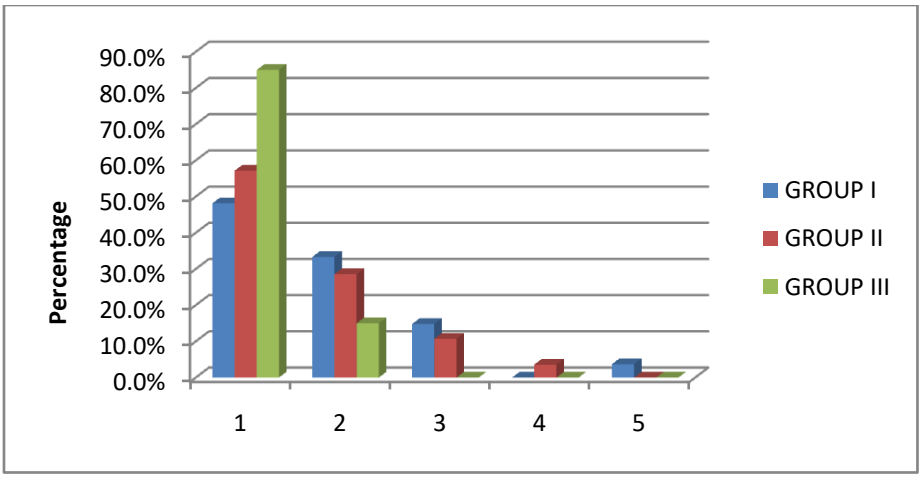


FIGURE 11 PATTERN OF PRBC TRANSFUSION

12) PATTERN OF FFP TRANSFUSION

In the study population (n=100) 19 neonates received FFP transfusion.

In group I 10 received FFP transfusion. 40% (n=4) received single unit FFP. 60% (n=6) received 6 units FFP.

In group II 3 received FFP transfusion. 33.3% (n=1) received single unit FFP. 33.3% (n=3) received 2 units PRBC and 33.3% (n=1) received 4 units FFP.

In group III 6 received FFP transfusion. 50% (n=3) received single unit FFP and 35% (n=3) received 2 units FFP.

TABLE 12 PATTERN OF FFP TRANSFUSION

		Gestation						Total	Chi-square value	p-value
		GROUP I		GROUP II		GROUP III				
FFP	1	4	40.0%	1	33.3%	3	50.0%	8	15.596	0.016
	2	0	0.0%	1	33.3%	3	50.0%	4		
	3	6	60.0%	0	0.0%	0	0.0%	6		
	4	0	0.0%	1	33.3%	0	0.0%	1		
Total		10	100.0%	3	100.0%	6	100.0%	19		

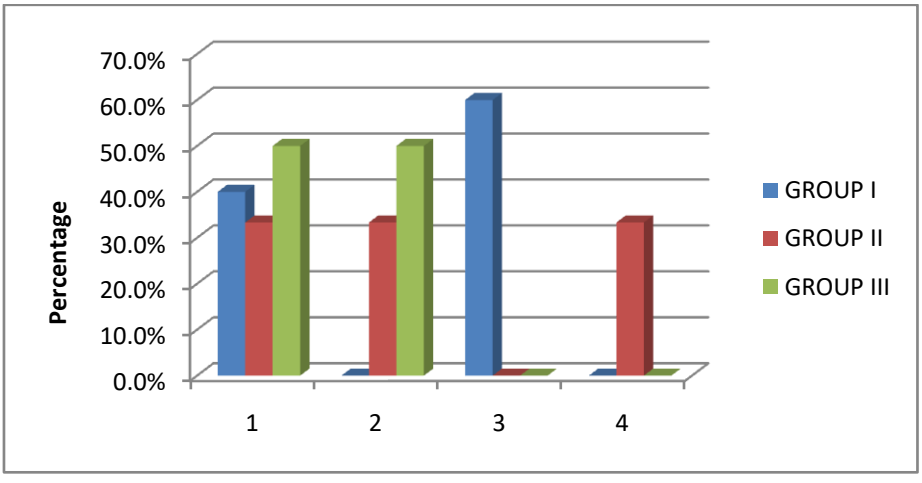


FIGURE 12 PATTERN OF FFP TRANSFUSION

13) PATTERN OF RDP TRANSFUSION

In the study population (n=100) 48 neonates received RDP transfusion.

In group I 19 received RDP transfusion. 47.4 (n=9) received single unit RDP. 31.6% (n=6) received 2 units RDP. 15.8% (n=3) received 3 units RDP and 5.3% (n=1) received 4 units RDP.

In group II 15 received RDP transfusion. 40% (n=6) received single unit RDP. 40% (n=6) received 2 units RDP. 13.3% (n=2) received 3 units RDP and 6.7% (n=1) received 6 units RDP.

In group III 14 received RDP transfusion. 42.9% (n=6) received 1 unit RDP, 50% (n=7) received 2 units RDP. 7.1% (n=1) received 3 units RDP.

TABLE 13 PATTERN OF RDP TRANSFUSION

		Gestation						Total	Chi-square value	p-value
		GROUP I		GROUP II		GROUP III				
RDP	1	9	47.4%	6	40.0%	6	42.9%	21	5.020	0.755
	2	6	31.6%	6	40.0%	7	50.0%	19		
	3	3	15.8%	2	13.3%	1	7.1%	6		
	4	1	5.3%	0	0.0%	0	0.0%	1		
	6	0	0.0%	1	6.7%	0	0.0%	1		
Total		19	100.0%	15	100.0%	14	100.0%	48		

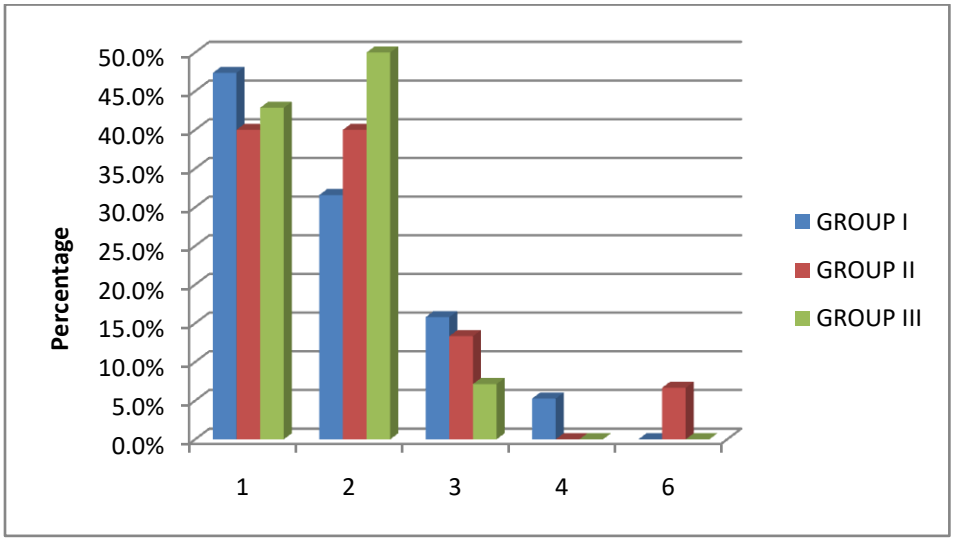


FIGURE 13 PATTERN OF RDP TRANSFUSION

14) TRANSFUSIONPATTERN IN SINGLETON VS MULTIPLE NEONATES

In the study population, 1.06 PRBC were transfused for a singelton neonate as compared to 1.64 for twin and 1.50 for a triplet.

In the study population, 0.33 FFP were transfused for a singelton neonate as compared to 0.55 for twin and 0.38 for a triplet.

In the study population, 0.79 RDP were transfused for a singelton neonate as compared to 1.09 for twin and 1.38 for a triplet.

TABLE 14.1 TRANSFUSION PATTERN IN SINGLETON VS MULTIPLE NEONATES

	Total		**PRBC**		**FFP**		**RDP**		**no.**
Single	177	2.19	86	1.06	27	0.33	64	0.79	81
Twin	36	3.27	18	1.64	6	0.55	12	1.09	11
Triplet	28	3.50	12	1.50	5	0.63	11	1.38	8
Total	241	2.41	116	1.16	38	0.38	87	0.87	100

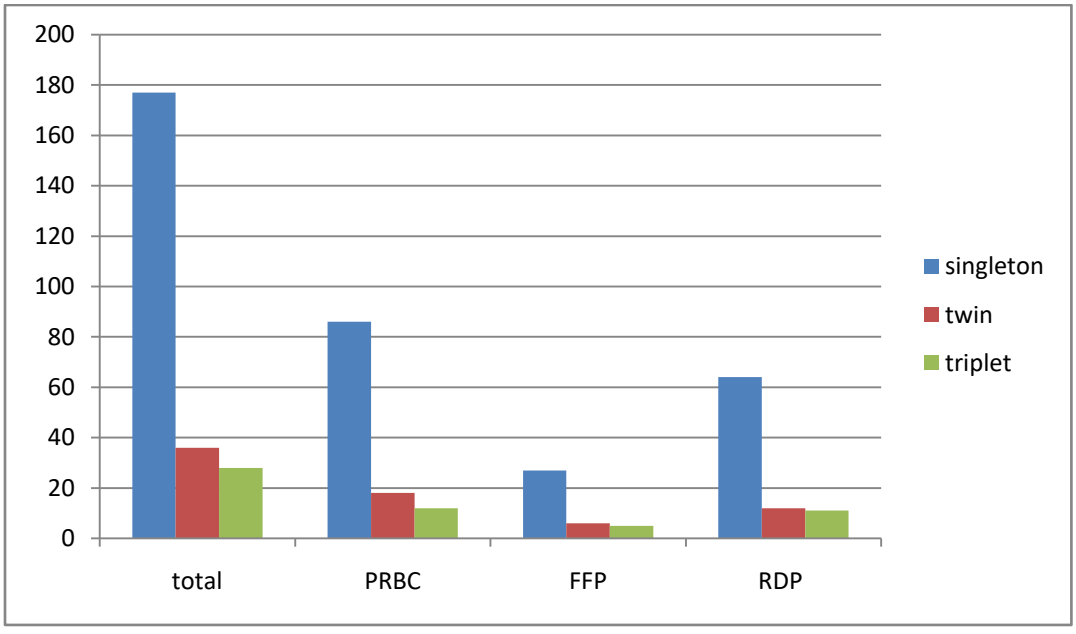


FIGURE 14.1 TRANSFUSION PATTERN IN SINGLETON VS MULTIPLE NEONATES

15) SINGLE & MULTIPLE TRANSFUSION

15.1) In the study population (n=100), 66 neonates were transfused 1 unit, 26 were transfused 2 units and 8 were transfused ≥ 3 units.

TABLE 15.1 SINGLE & MULTIPLE TRANSFUSION

Tansfused	No. of cases	Percentage
1	66	66.0%
2	26	26.0%
3	8	8.0%
Total	100	100.0%

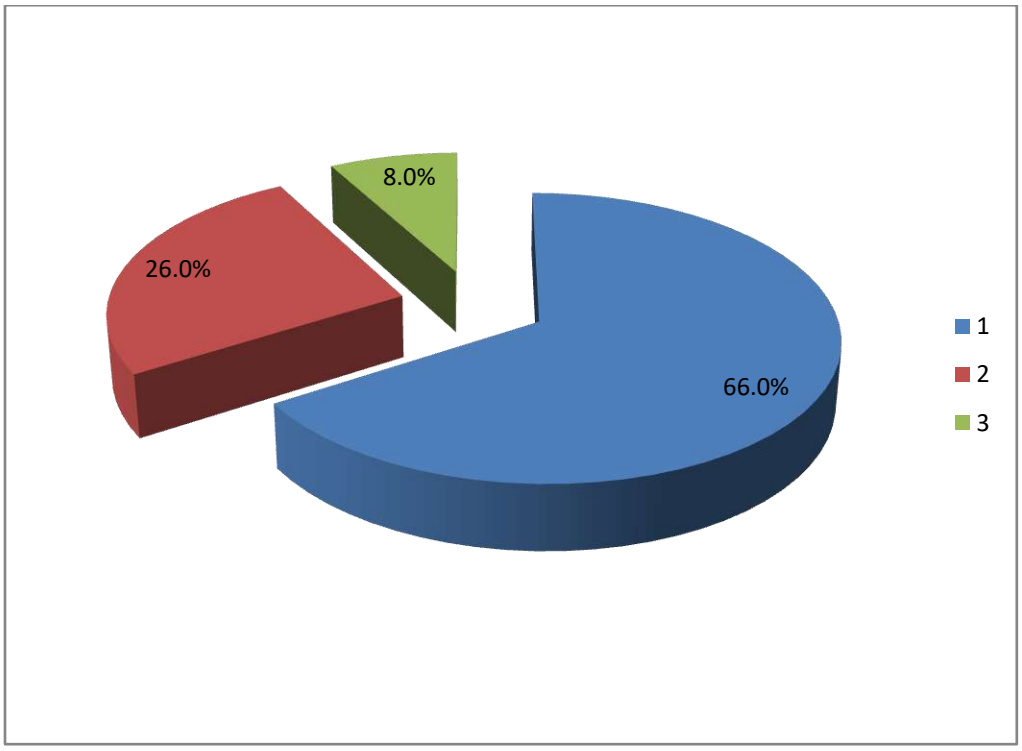


FIGURE 15.1 SINGLE & MULTIPLE TRANSFUSION

15.2) Group wise trends are depicted in the table and graphs below.

TABLE 15.2 SINGLE & MULTIPLE TRANSFUSION

		Gestation						Total	Chi-square value	p-value
	No. of units	GROUP I		GROUP II		GROUP III				
Tansfused	1	13	40.6%	28	77.8%	25	78.1%	66	13.867	0.008
	2	14	43.8%	6	16.7%	6	18.8%	26		
	≥3	5	15.6%	2	5.6%	1	3.1%	8		
Total		32	100.0%	36	100.0%	32	100.0%	100		

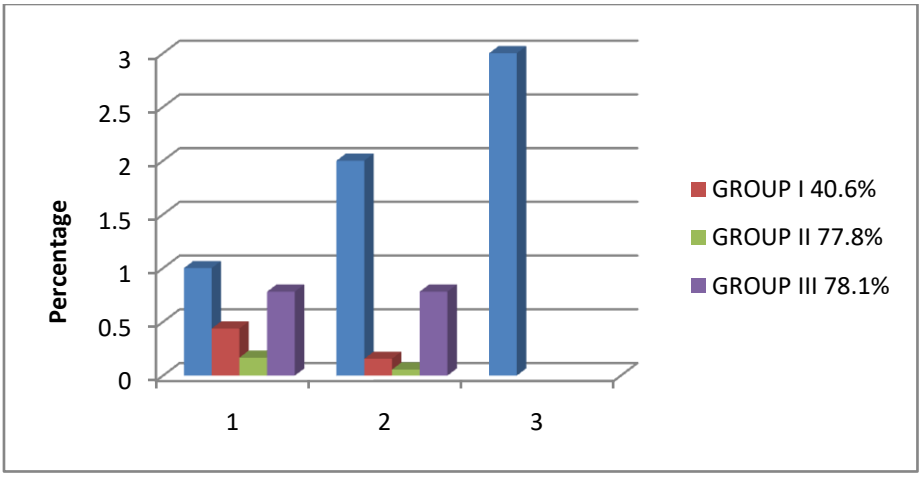


FIGURE 15.2 SINGLE & MULTIPLE TRANSFUSION

16) TRENDS OF COMPONENT TRANSFUSION

16.1) In the study population, n=100, 5% received only FFP transfusion, 41% received PRBC transfusion, 6% received a combination of PRBC and FFP transfusion, 8% received PRBC, FFP and RDP transfusion, 20% received PRBC and RDP transfusion and 20% received only RDP transfusion.

TABLE 16.1 TRENDS OF COMPONENT TRANSFUSION

	No. of cases	Percentage
FFP	5	5.0%
PRBC	41	41.0%
PRBC,FFP	6	6.0%
PRBC,FFP,RDP	8	8.0%
PRBC,RDP	20	20.0%
RDP	20	20.0%
Total	100	100.0%

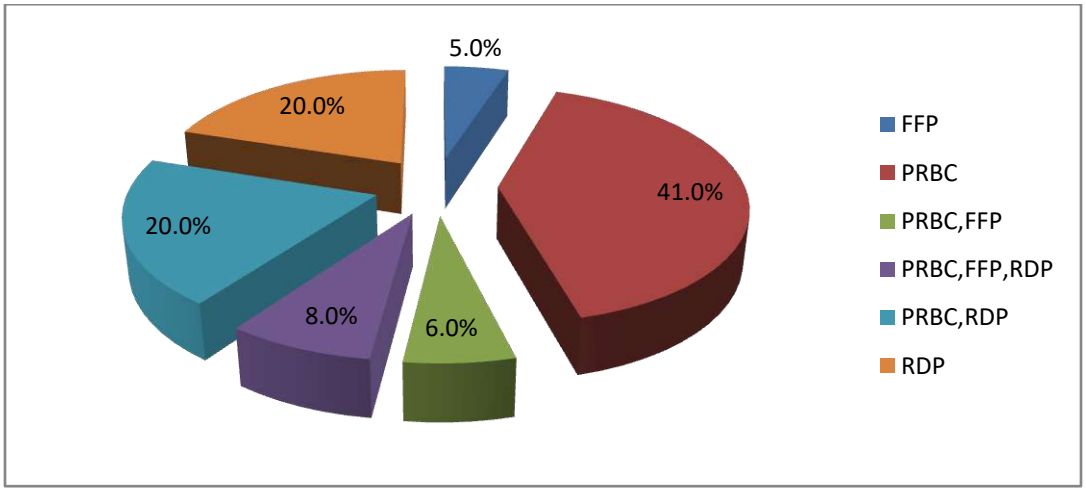


FIGURE 16.1 TRENDS OF COMPONENT TRANSFUSION

16.2) Group wise trends of component transfusion

In group I(n=32), 3.1% received only FFP transfusion, 25% received PRBC transfusion, 12.5% received a combination of PRBC and FFP transfusion, 15.6% received PRBC, FFP and RDP transfusion, 31.3% received PRBC and RDP transfusion and 12.5% received only RDP transfusion.

In group II (n=36), 0% received only FFP transfusion, 55.6% received PRBC transfusion, 2.8% received a combination of PRBC and FFP transfusion, 5.6% received PRBC, FFP and RDP transfusion, 13.9% received PRBC and RDP transfusion and 22.2% received only RDP transfusion.

In group III (n=32), 12.5% received only FFP transfusion, 40.6% received PRBC transfusion, 3.1% received a combination of PRBC and FFP transfusion, 3.1% received PRBC, FFP and RDP transfusion, 15.6% received PRBC and RDP transfusion and 25% received only RDP transfusion.

TABLE 16.2 TRENDS OF COMPONENT TRANSFUSION

		GESTATION						Total	Chi-square value	p-value
		GROUP I		GROUP II		GROUP III				
Tansfused	FFP	1	3.1%	0	0.0%	4	12.5%	5	20.739	0.023
	PRBC	8	25.0%	20	55.6%	13	40.6%	41		
	PRBC,FFP	4	12.5%	1	2.8%	1	3.1%	6		
	PRBC,FFP, RDP	5	15.6%	2	5.6%	1	3.1%	8		
	PRBC,RDP	10	31.3%	5	13.9%	5	15.6%	20		
	RDP	4	12.5%	8	22.2%	8	25.0%	20		
Total		32	100.0%	36	100.0%	32	100.0%	100		

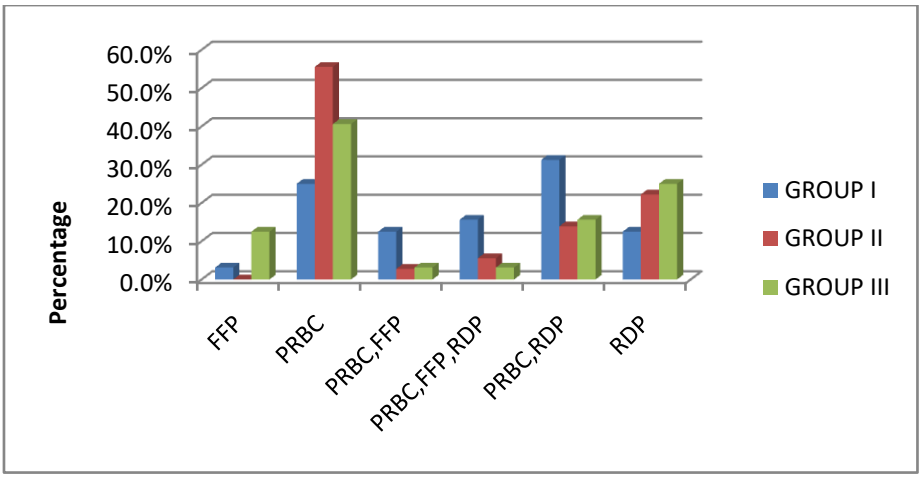


FIGURE 16.2 TRENDS OF COMPONENT TRANSFUSION

17) POST TRANSFUSION COMPLICATIONS

17.1) TRANSFUSION REACTION (T.R)

In the study population (n=100), none of the subjects reported transfusion reaction

TABLE 17.1 TRANSFUSION REACTION (T.R)

		Gestation						Total
		GROUP I		GROUP II		GROUP III		
T.R	N	32	100.0%	36	100.0%	32	100.0%	100
Total		32	100.0%	36	100.0%	32	100.0%	100

17.2) NECROTISING ENTEROCOLITIS (NEC)

In the study population (n=100), 16 subjects experienced necrotizing enterocolitis after transfusion.

In group I (n=32), 21.9% had NEC.

In group II (n=36), 11.1% had NEC.

In group III (n=32), 15.6% had NEC

TABLE 17.2 NECROTISING ENTEROCOLITIS (NEC)

		Gestation						Total	Chi-square value	p-value
		GROUP I		GROUP II		GROUP III				
NEC	N	25	78.1%	32	88.9%	27	84.4%	84	1.465	0.481
	Y	7	21.9%	4	11.1%	5	15.6%	16		
Total		32	100.0 %	36	100.0 %	32	100.0 %	100		

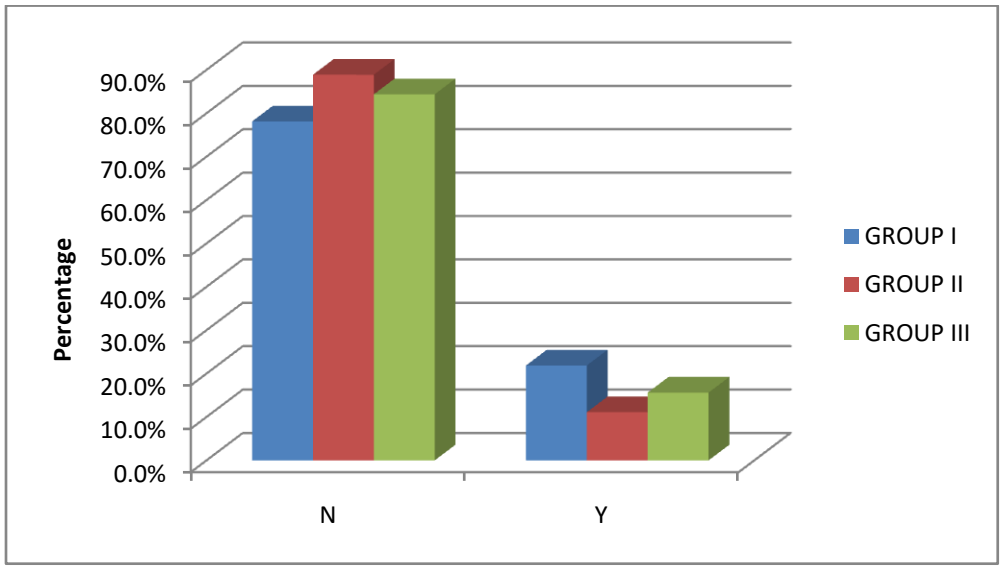


FIGURE 17.2 NECROTISING ENTEROCOLITIS (NEC)

17.3) DISTRESS

In the study population (n=100), 32 subjects had distress after transfusion.

In group I (n=32), 40.6% experienced distress.

In group II (n=36), 38.9% experienced distress.

In group III (n=32), 15.6% experienced distress.

TABLE 17.3 DISTRESS

		Gestation						Total	Chi-square value	p-value
		GROUP I		GROUP II		GROUP III				
DISTRESS	N	19	59.4 %	22	61.1 %	27	84.4%	68	5.822	0.054
	Y	13	40.6 %	14	38.9 %	5	15.6%	32		
Total		32	100.0 %	36	100.0 %	32	100.0 %	100		

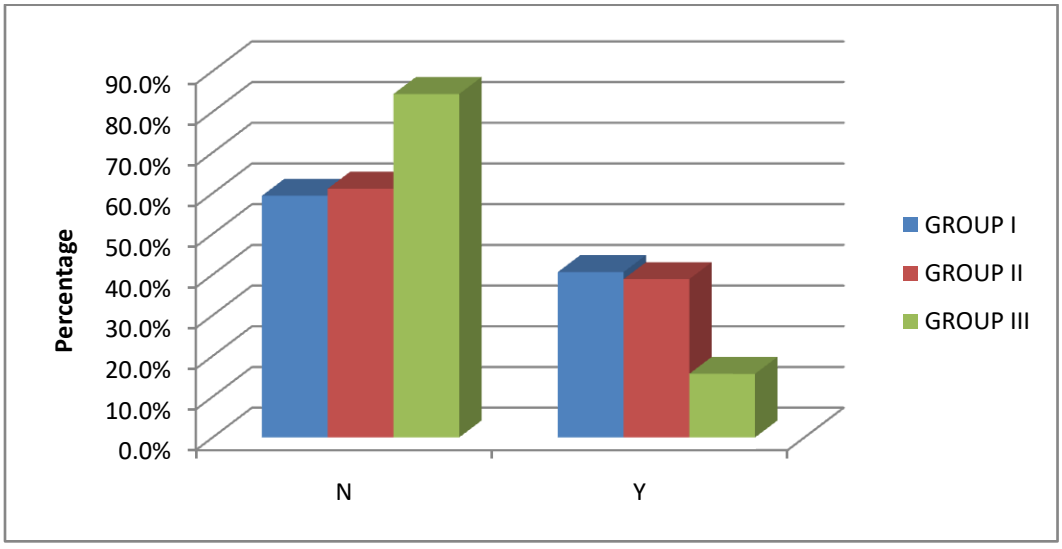


FIGURE 17.3 DISTRESS

17.4) OTHER

No other complication was reported in the study population

TABLE 17.4 OTHER

		Gestation						Total
		GROUP I		GROUP II		GROUP III		
OTHER	N	32	100.0%	36	100.0 %	32	100.0%	100
Total		32	100.0%	36	100.0 %	32	100.0%	100

17.5) NO COMPLICATION

In the study population (n=100), 51 subjects had no symptom after transfusion

TABLE 17.5 NO COMPLICATION

		Gestation						Total	Chi-square value	p-value
		GROUP I		GROUP II		GROUP III				
NONE	N	21	65.6%	18	50.0%	10	31.3%	49	7.588	0.023
	Y	11	34.4%	18	50.0%	22	68.8%	51		
Total		32	100.0%	36	100.0%	32	100.0%	100		

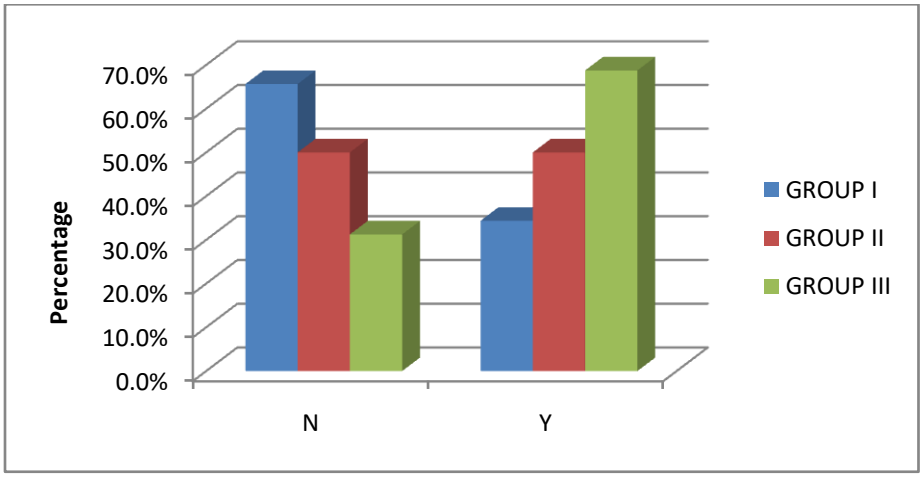


FIGURE 17.5 NO COMPLICATION

18) OUTCOME

In the study population (n=100), 32 died, 57 were discharged and 11 left against medical advice.

In group I (n=32), 59.4% died, 34.4% were discharged and 6.3% left against medical advice.

In group II (n=36), 25% died, 61.1% were discharged and 13.9% left against medical advice.

In group III (n=32), 12.5% died, 75% were discharged and 12.5% left against medical advice.

P value =0.001, so significant correlation between age of gestation and outcome.

Table 18.1 OUTCOME

		Gestation						Total	Chi-square value	p-value
		GROUP I		GROUP II		GROUP III				
OUTCOME	DEATH	19	59.40%	9	25.00%	4	12.50%	32	17.642	0.001
	DISCHARGE	11	34.40%	22	61.10%	24	75.00%	57		
	LAMA	2	6.30%	5	13.90%	4	12.50%	11		
Total		32	100.0%	36	100.00%	32	100.00%	100		

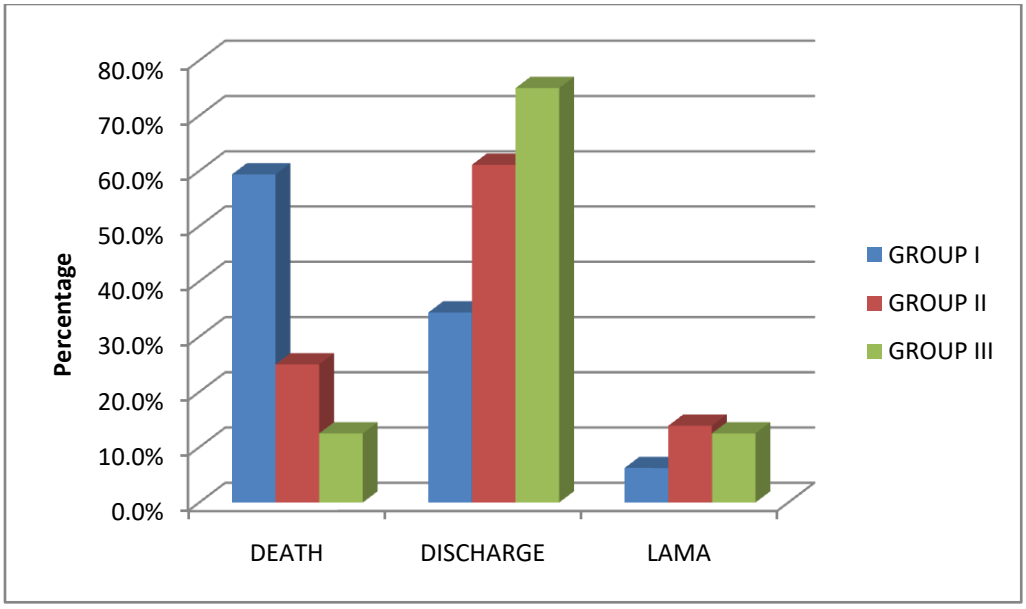


FIGURE 18.1 OUTCOME

TABLE 18.2 OUTCOME

Gestation			OUTCOME			Total	Chi-square value	p-value
			DEATH	DISCHARGE	LAMA			
GROUP I	PRBC	1	8	4	1	13	0.430	0.806
		>1	7	6	1	14		
	Total		15	10	2	27		
GROUP II	PRBC	1	4	10	2	16	0.438	0.804
		>1	4	6	2	12		
	Total		8	16	4	28		
GROUP III	PRBC	1	2	13	2	17	1.176	0.555
		>1	0	2	1	3		
	Total		2	15	3	20		

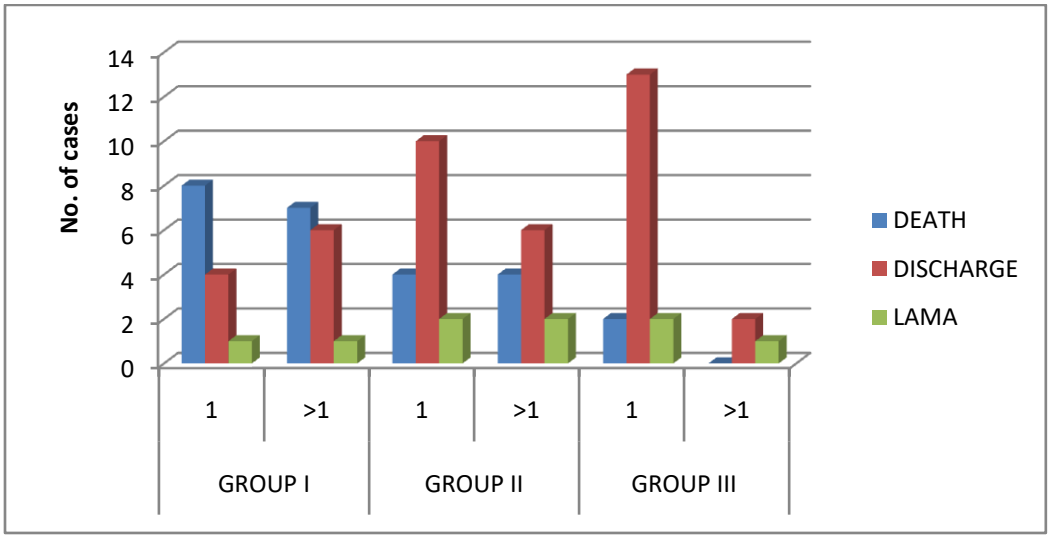


FIGURE 18.2 OUTCOME

TABLE 18.3 OUTCOME

Gestation			**OUTCOME**			Total	Chi-square value	p-value
			DEATH	**DISCHARGE**	**LAMA**			
GROUP I	MULTIPLE BABY	SINGLETON	10	9	2	21	3.882	0.422
		TWINS	6	1	0	7		
		TRIPLETS	3	1	0	4		
	Total		19	11	2	32		
GROUP II	MULTIPLE BABY	SINGLETON	6	19	5	30	2.945	0.567
		TWINS	1	1	0	2		
		TRIPLETS	2	2	0	4		
	Total		9	22	5	36		
GROUP III	MULTIPLE BABY	SINGLETON	4	22	4	30	0.711	0.701
		TWINS	0	2	0	2		
	Total		4	24	4	32		

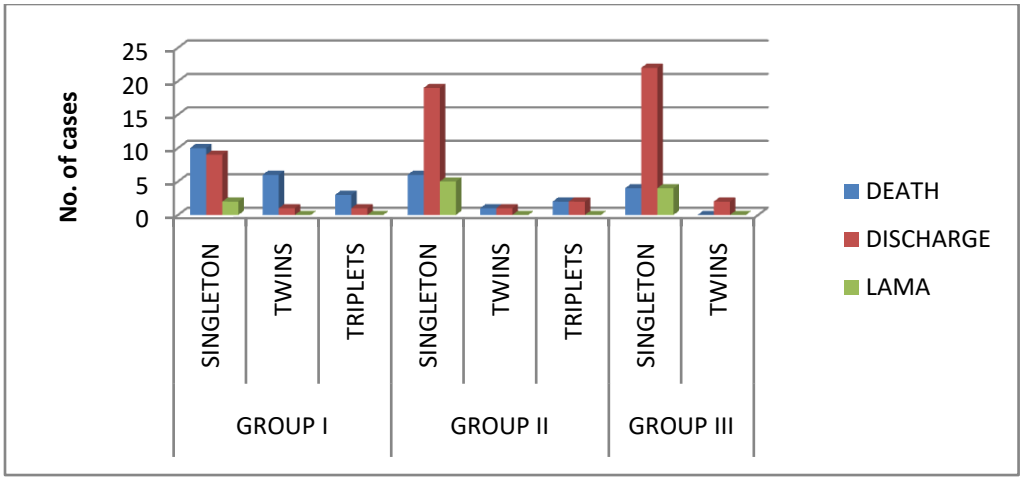


FIGURE 18.3 OUTCOME

TABLE 18.4 OUTCOME

Gestation			OUTCOME			Total	Chi-square value	p-value
			DEATH	DISCHARGE	LAMA			
GROUP I	Tansfused units	1	6	5	2	13	4.092	0.394
		2	9	5	0	14		
		≥3	4	1	0	5		
	Total		19	11	2	32		
GROUP II	Tansfused units	1	5	18	5	28	7.965	0.093
		2	4	2	0	6		
		≥3	0	2	0	2		
	Total		9	22	5	36		
GROUP III	Tansfused units	1	3	18	4	25	9.280	0.054
		2	0	6	0	6		
		≥3	1	0	0	1		
	Total		4	24	4	32		

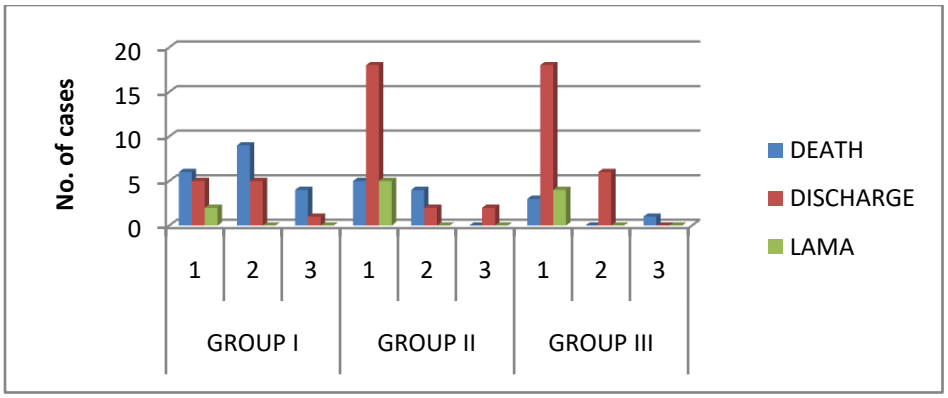


FIGURE 18.4 OUTCOME

TABLE 18.5 OUTCOME

Gestation			OUTCOME			Total	Chi-square value	p-value
			DEATH	DISCHARGE	LAMA			
GROUP I	Tansfused	FFP	1	0	0	1	10.067	0.435
		PRBC	2	4	2	8		
		PRBC,FFP	3	1	0	4		
		PRBC,FFP,RDP	4	1	0	5		
		PRBC,RDP	6	4	0	10		
		RDP	3	1	0	4		
	Total		19	11	2	32		
GROUP II	Tansfused	PRBC	4	12	4	20	9.287	0.319
		PRBC,FFP	1	0	0	1		
		PRBC,FFP,RDP	0	2	0	2		
		PRBC,RDP	3	2	0	5		
		RDP	1	6	1	8		
	Total		9	22	5	36		
GROUP III	Tansfused	FFP	1	3	0	4	11.462	0.323
		PRBC	1	9	3	13		
		PRBC,FFP	0	1	0	1		
		PRBC,FFP,RDP	1	0	0	1		
		PRBC,RDP	0	5	0	5		
		RDP	1	6	1	8		
	Total		4	24	4	32		

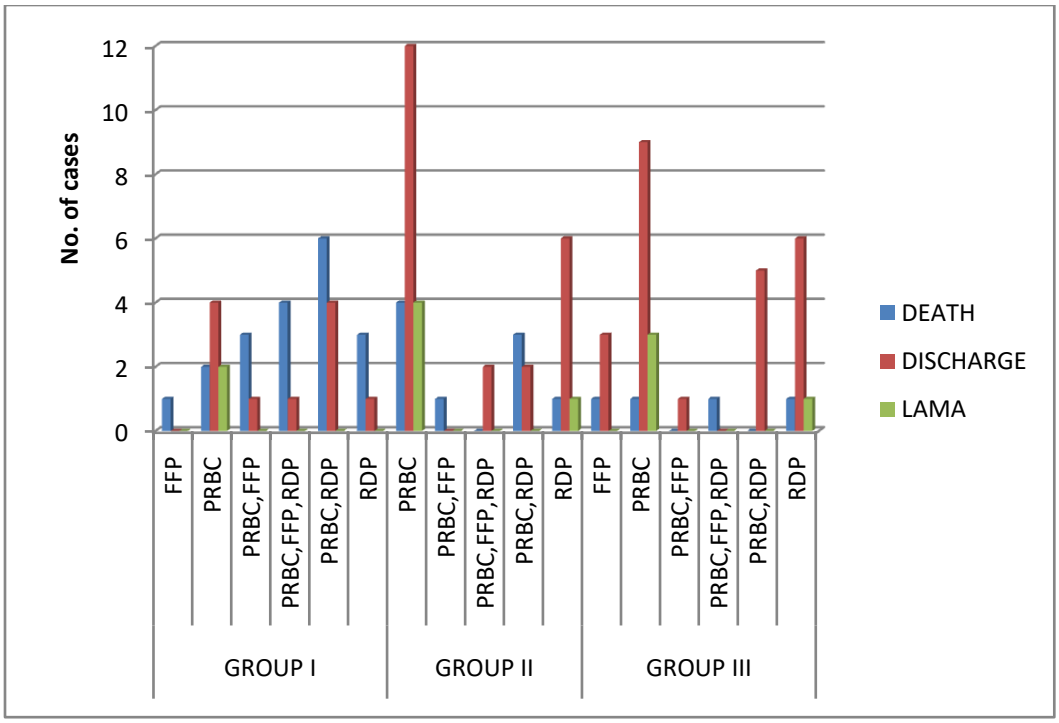


FIGURE 18.5 OUTCOME

19) INCREASE IN Hb AFTER PRBC TRANSFUSION

In the study population (n=100), 75 PRBC were transfused. Mean pre transfusion hemoglobin was 8.02 g/dL and post transfusion hemoglobin was 11.24 g/dL.

TABLE 19.1 INCREASE IN Hb AFTER PRBC TRANSFUSION

	N	Mean	Std. Deviation	Std. Error Mean	**t**	**p-value**	**Mean difference**	**SD difference**
PRE Hb (g/dL)	75	8.02	1.249	.147	-22.179	0.001	-3.219	1.232
POST Hb (g/dL)	75	11.24	1.678	.198				

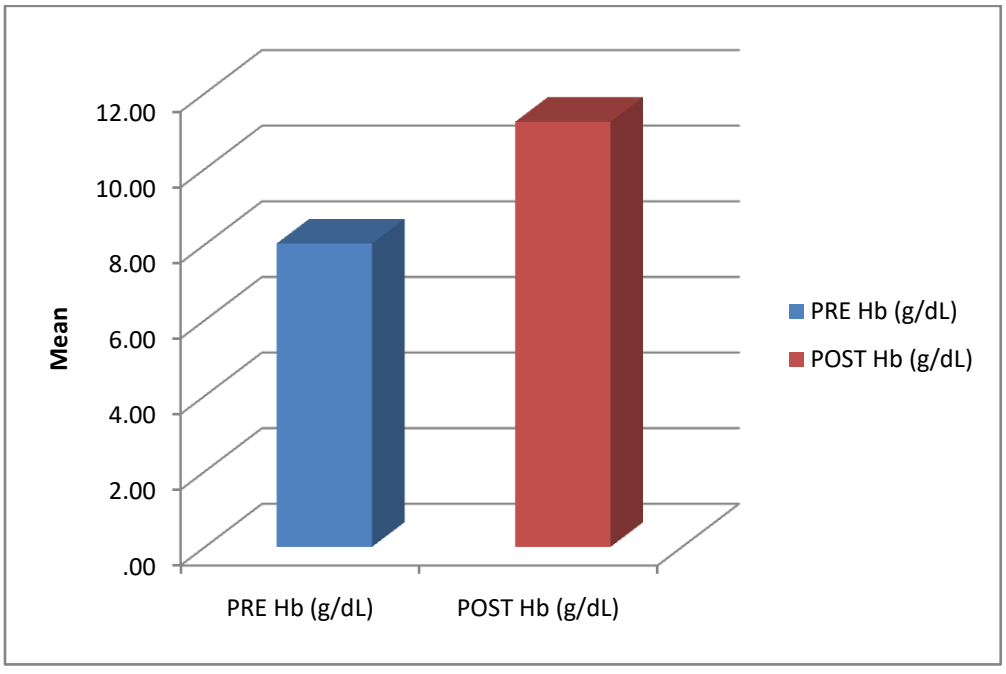


FIGURE 19.1 INCREASE IN Hb AFTER PRBC TRANSFUSION

20) DECREASE IN INR AFTER FFP TRANSFUSION

In the study population (n=100), 19 FFP were transfused. Mean INR before FFP transfusion was 3.09 and post FFP transfusion was 1.74

TABLE 20.1 DECREASE IN INR AFTER FFP TRANSFUSION

	N	Mean	Std. Deviation	Std. Error Mean	t	p-value	Mean difference	SD difference
PRE INR	19	3.09	1.221	.326	5.678	0.001	1.352	0.891
POST INR	19	1.74	.423	.113				

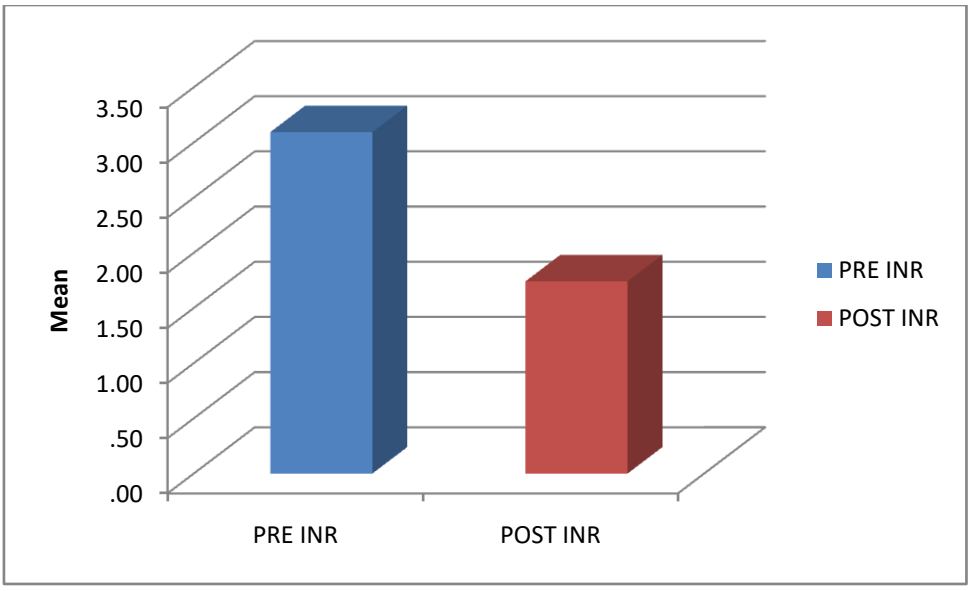


FIGURE 20.1 DECREASE IN INR AFTER FFP TRANSFUSION

21) INCREASE IN PLATELET COUNT AFTER RDP TRANSFUSION

In the study population (n=100), 47 RDPs were transfused. Mean platelet count before transfusion was 55 and post transfusion was 111.

TABLE 21.1 INCREASE IN PLATELET COUNT AFTER RDP TRANSFUSION

	N	Mean	Std. Deviation	Std. Error Mean	**t**	**p-value**	**Mean difference**	**SD difference**
PRE PLT (10^3/ µL)	48	55.89	35.314	5.151	-9.191	0.001	-55.362	41.296
POST PLT(10^3/ µL)	48	111.26	46.499	6.783				

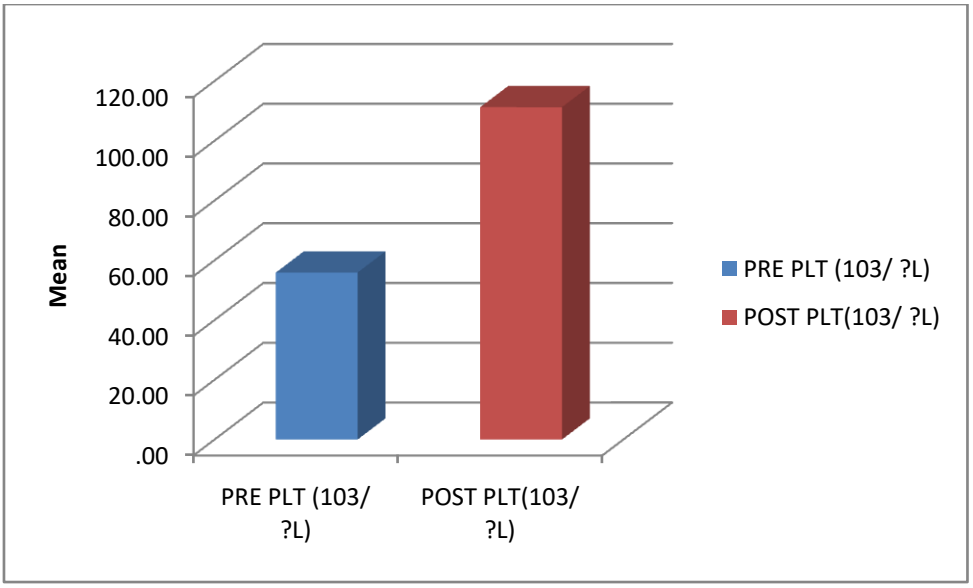


FIGURE 21.1 INCREASE IN PLATELET COUNT AFTER RDP TRANSFUSION

DISCUSSION

During the course of this study several variables were studied to identify the determinants and the pattern of usage of blood and blood components in neonates. The determinants constituted neonatal factors like sex, gestational age, weight and presence of comorbidities.

NEONATE FACTORS

1. SEX:

In our study, 63% subjects were male and 37% female. Similarly in another study 71.4% were male and 28.6% were female[2], in a second study 71.96% were male and 28.04% were female[47], 61.4% males and 38.6% females in Rahim et al[48] Similarly In Amrutiya et al 75.3% were male and the rest were female[5]An Iraqi study suggests that this results due to male susceptibility to complications of RDS and need respiratory support so need blood transfusion more than female.[48]

TABLE No. 22

STUDY	OUR STUDY	Ogunlesi TA et al	Hameed et al	Rahim et al	Amrutiya et al
MALE	63%	71.4%	61.4%	71.96%	75.3%
FEMALE	37%	28.6%	38.6%	28.04%	24.7%

2. GESTATIONAL AGE (GA):

In the study population, 32% were very preterm, 36% were preterm and 32% were term babies. The neonates in the very preterm and preterm group were transfused more than the term group. This is in comparison to Boo et al where 22.7% of the neonates were extreme preterm, 25.5 were very preterm, 15.5% were late preterm and 36.4% were term neonates[49]

In contrast Rahim et al reported 26.50% premature and 73.5 term neonates.[48]

TABLE No.23

Study	This study	Boo et al	Rahim et al
Pre-term	68%	63.6%	26.5%
Term	32%	36.4%	73.5

3. BIRTH WEIGHT

In the study population, 15% were ELBW, 25% were VLBW, 32%were LBW and 28% were NW. Lower birth weight babies required significantly higher transfusion as compared to the normal birth weight group. These findings are relatable to Amrutiya et al where 9.7% were extremely low birth weight, 22.6% were very low birth weight, and 40.9% were low birth weight[5]

Boo et al distribution of neonates according to weight was ELBW 13.6%, VLBW 25.5%, LBW 25.5%, NW 35.4%[49] Similarly in an Indian study , transfusion requirements were highest among infants whose GA was <28 weeks and birth weight < 1000g[50]

TABLE No. 24

	This study	Amrutiya et al	Boo et al
ELBW	15%	9.7%	13.6%
VLBW	25%		25.5%
LBW	32%	22.6% (VLBL+LBW)	25.5%
NW	28%	40.9%	35.4%

4) NUMBER OF BABIES

In the study population 81%were singleton, 11% were twins and 8% were triplets. This is comparable to Amrutiya et al where 93.8% were a singleton pregnancy and 6.2% were twin pregnancies.[5] In Batra and Rabe 65 twins were compared with 26 singletons in 91 subjects[51]

TABLE No. 25

	This study	Amrutiya et	In Batra and Rabe
Singleton	81%	93.8%	28.58%
Multiple gestation	19%	6.2%	71.42%

5) MEAN DONOR EXPOSURE

In the present study, the mean donor exposure was 2.41.In contrast Donitz et al report the mean donor exposure 6.9.

In this study, every singleton neonate was transfused with 2.19 units of blood or blood component as compared to 3.27 for each twin and 3.50 for each triplet. This is comparable Batra and Rabe where mean number of blood transfusion was 2.4 for twins and 0.88 for singletons.[51]

6) AGE OF THE NEONATE AT WHICH FIRST TRANSFUSION WAS GIVEN

In this study, 43% neonates received 1st transfusion in the first week of life, 25% neonates received 1st transfusion in the second week of life, 17% neonates received 1st transfusion in the third week of life and 15% neonates received 1st transfusion in the fourth week of life. These findings are comparable to Amrutiya et al where 81.5% neonates required

transfusion during the first week of life[5] Similarly in TA Ogunlesihalf the transfusions took place during the first week of life indicating the role of perinatal events in the conditions warranting transfusion.[52]

In contast a study from Iraq reported The most common age group of receiving blood product transfusion was (22–28) days (40.0%), followed by those whose age (1–7) days (27.8%)[48]

7) NEED OF TRANSFUSION IN RELATION TO RDS

In the study population, 55% of the transfused neonates had Respiratory distress syndrome (p value =0.001, significant).

In the very preterm group (n=32), 100% neonates had respiratory distress syndrome. In preterm group (n=36), 63.9% had Respiratory distress syndrome. Incidence of RDS was inversely related to GA. Our results were similar to Qari et al study in which 14.4% of RDS cases were extreme preterm, 86.5%were preterm babies with mother's gestational age ranged from 30-36 weeks while 4.4% and 4.7% of newborn were late preterm and full term respectively.[53]

No significant relation between RDS and need of transfusion was observed. Similarly In TA Ogunlesi, there was no significant difference in the proportion of babies with and without respiratory distress who had blood transfusion[52]

8) NEED FOR RESPIRATORY SUPPORT

In this study 74% needed respiratory support during hospital stay. 49% patients required mechanical ventilation, 48% needed CPAP, 34% needed Nasal cannula, 25% needed nasal oxygen prongs and 26% didn't need any respiratory support during hospital stay.

These findings were comparable to another study in which, 61.4% needed respiratory supports divided into mechanical ventilation in 31.4%, on nasal

O2 in 17.1% then on continuous positive airway pressure (CPAP) in 12.9% while (38.6%) did not receive respiratory support.[48]

TABLE No. 26

	This study	Rahim et al
Mechanical ventilation	49%	31.4%
CPAP	48%	12.9%
Nasal cannula and Nasal oxygen prongs	59%	17.1%
None	26%	38.6%

PATTERN OF TRANSFUSION

In the present study, 241 transfusions were given to 100 neonates. In Ogunlesi TA et al[52] 251 transfusions were given to 112 neonates. In Boo et al 223 transfusions were given to 110 neonates[49]In Kaur et al 557 transfusions were given to 280 neonates.[54]

In the present study, 75% neonates received 116 packed red cells, 48% neonates received 87 platelets, 19% neonates received 38 FFP. Whole blood, Cryoprecipitate and single donor platelets were not used in the study. In Kaur et al, 54.7% received platelets and 24.5% received packed red cells[54] IncontrastGiridharan et alstudy, 53% received platelets, 35% received packed red cells, 10% received FFP and 2% received cryoprecipitate[28] In Ogunlesi TA et al 66.1% received packed red cells and 8% received plasma.[52] In Ramanathan et al, 54.5% received platelets[55] In Bowen et al, 88.9% received packed red cells and 23.9% received platelets[56]

In the present study, PRBC with RDP (20%) was the commonly used combination of blood components in neonates. The other commonly used

combinations were packed red cells with FFP, packed red cells with platelets and platelets with FFP.

TABLE NO 27

	This study	Kaur et al	Giridharan et al study	Ogunlesi TA et al	Ramanathan et al	Bowen et al	Amrutiya et al
PRBC	75%	24.5%	35%	66.1%		88.9%	31.34%
RDP	48%	54.7%	53%	25.9%	54.5%	23.9%	28.14%
FFP	19%		10%	8%			37.82%

1) PRBC TRANSFUSION PATTERN

In this study, 75% subjects received PRBC transfusions. It was the most commonly transfused blood component. This is in accordance with N A Murray and A G Roberts review which states Packed red blood cells (RBCs) are the most common blood product administered to sick neonates[23] In a study from Iraq 63% subjects received Packed red blood cell (PRBC).[48]In contrast to our findings Amrutiya et al state that 31.34% transfusions were red cell concentrate[5]

No significant association between prematurity and PRBC transfusion was found. Average Pre transfusion Hb in g/dl was 8.02 and post transfusion Hb was 11.24. The difference between means of post-transfusion and pre-transfusion Hb was significant P value (<0.001). Our results are comparable to an Indian study where, mean hemoglobin improvement after PRBC transfusions was 2.3 ± 2.1 g/dl.[50]

In Kaur et al Mean hemoglobin at the time of transfusion of packed red blood cell was 8.2 g/dl.[54]

This rise is comparable to Canadian Blood Services hypothesis that states “In general, a dose of 15 ml/kg can be expected to raise the baby’s hemoglobin (Hb) concentration by about 20 g/l (2g/dl)” [57]

2) RDP TRANSFUSION PATTERN

In this study 48% subjects were transfused with RDPs. In contrast, in Amrutiya et al 28.14% transfusions were platelet concentrates[5]

Mean pre RDP transfusion platelet count was 55.89x 10^{9} /l and post RDP transfusion count was 111 x 10^{9} / l. The difference between means of post-transfusion and pre-transfusion platelet count was significant P value (<0.001).In a similar study from india the mean platelet count for transfusing the platelets was 35,458/dl.[54]

According to the Canadian Blood services, Platelets are generally given in doses of 5–10 ml per kg, which should be expected to increase the platelet count of a full-term infant by 50–100 x 10^{9}/l [57]which is comparable to our findings.

Though our threshold value of platelet was higher it is comparable to A recent survey of platelet transfusion practices among U.S. and Canadian neonatologists which revealed wide practice differences in regard to platelet transfusion thresholds in different clinical scenarios, and suggested that a high proportion of platelet transfusions were given to non-bleeding neonates with platelet counts between 50 and 100 × 109 /L, particularly in the first week of life[41]

3) FFP TRANSFUSION PATTERN

In this study, 19% of the subjects received FFP transfusion. In contrast, in Amrutiya et al 37.82% transfusions were fresh frozen plasma[5]

Mean pre transfusion INR was 3.09, while post ffp transfusion INR was 1.74. The difference between means of post-transfusion and pre-transfusion INR was significant P value (<0.001). Our result was similar to Dogra et al study where The pre-transfusion mean INR was 2.37 ± 0.48

(Range 1.19–2.96). The post-transfusion mean INR was 1.53 ± 0.46 (1.00–2.43).[35]

In contrast another study reported mean decrease from pre transfusion INR values by 0.3 ± 0.6.[50]

4) SINGLE VS MULTIPLE TRANSFUSIONS

In our study, 66% subjects were given a single transfusion while 34% received multiple transfusion. Preterm neonates were the majority receivers of multiple transfusions. In contrast a study reports 68.3% infants received multiple transfusions[50]

In this study, 66% neonates were transfused 1 unit, 26% were transfused 2 units and 8% were transfused ≥ 3 units.

In Amrutiya et al the majority of neonates require multiple transfusions. Fourteen(4.12%) neonates required up to 10 transfusions, two neonates required up to 22 transfusions, and 58 neonates required more than five blood transfusions[5]

5) OUTCOME

In this study 32% subjects died, 57% were discharged and 11% left against medical advice. In contrast Out of 340 neonates, 317 survived and were discharged in Amrutiya et al[5]

SUMMARY AND CONCLUSION

- In this study, 100 neonates were enrolled, 37 females and 63 males.
- Neonates were divided into 3 groups based on gestational age (GA):
    - Group I : Very preterm (gestation age ≤ 32 weeks)
    - Group II: Preterm (gestation age >32 weeks to <36 weeks)
    - Group III: Term (gestational age ≥36 weeks)

- Neonates were also categorized into 4 categories according to birth weight:
    - Extremely low birth weight, weight ≤1000g
    - Very low birth weight, weight >1000g and < =1500g
    - Low birth weight, weight >1500g and ≤2500g
    - Normal birth weight, weight > 2500g
- Depending on Apgar score, neonates were classified as Low, Intermediate or High apgar score neonates.
- Of the 100 subjects, 81were singleton neonates, 11were twins while 8 were triplets.
- 68% of the neonates were premature while 32% were term.
- 55% neonates had respiratory distress, 36% had neonatal hyperbilirubinemia and 3% had other congenital malformations.
- 74% subjects needed respiratory support during hospital stay while 26% did not need any support
- 43% neonates required transfusion support within 1st week of life.
- Low hemoglobin was the most common indication of transfusion followed by thrombocytopenia, active bleeding and sepsis with shock.
- 75% neonates received PRBC transfusion. It was the most frequently transfused blood product.
- 48% neonates were transfused with RDPs and 19% neonates were transfused with FFPs.

- In the study 66% neonates had a single transfusion while 34% had multiple transfusions.
- Mean increase of 3.22 g/dL in hemoglobin was observed after transfusion of 1 aliquot of PRBC.
- Mean decrease of 1.3 in INR was observed after transfusion of 1 aliquot of FFP
- Mean increase of 56 x 10^3/microliter platelets was observed after 1 unit RDP transfusion.
- 49% neonates experienced transfusion related complications including necrotizing enterocolitis and distress.
- 32% neonates died during follow up and 57% were discharged. Worse outcomes were seen mostly in very preterm neonates.

CONCLUSION

Neonatal transfusion requirement varies with parameters like gestational age, birth weight, multiple gestation etc. so, while considering the necessity for transfusing blood components to neonates these parameters along with normal physiological changes after birth should be taken into consideration. On analyzing the blood utilization practices among neonates in our study, current guidelines of transfusion practice from AIIMS are being followed appropriately. In our study, gestational age, birth weight and number of babies had a significant association with transfusion requirement. Very low birth weight premature neonates need most frequent transfusions, also very sick neonates need multiple transfusions . This increases donor exposure and increases related risks of transfusion. This could be avoided by usage of Pedipacks or aliquoting with the aid of SCD from single units. This study emphasizes the rational use of blood and its components and reduction of multiple donor exposure. All PRBC and RDP transfusions were done with leukoreduced units thus, no

transfusion reactions were observed. NEC and distress were the only post transfusion complications observed but can be attributed to illness and prematurity.

BIBLIOGRAPHY

1. Newborn health. Accessed October 27, 2022. https://www.who.int/westernpacific/health-topics/newborn-health.

2. Ogunlesi TA, Ogunfowora OB. Pattern and determinants of blood transfusion in a Nigerian neonatal unit. *Niger J ClinPract*. 2011;14:354-58.

3. Dogra K, Kaur G, Basu S, Chawla D. Red Cell Transfusion Practices in Neonatal Intensive Care Unit: An Experience from Tertiary Care Centre. *Indian J Hematol Blood Transfus*. 2018;34:671-6.

4. New HV, Berryman J, Bolton-Maggs PH, Cantwell C, Chalmers EA, Davies T, et al. Guidelines on transfusion for fetuses, neonates and older children. British journal of haematology. 2016;175:784-28.

5. Amrutiya RJ, Mungala BM, Patel VT, Ganjiwale JD, Nimbalkar SM. Blood Component Transfusion in Tertiary Care Neonatal Intensive Care Unit and Neonatal Intermediate Care Unit: An Audit. *Cureus*. 12:e9952.

6. Recommendations for transfusion therapy in neonatology. Accessed January 21, 2023. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4607607

7. Strauss RG. Anaemia of prematurity: pathophysiology and treatment. *Blood Rev*. 2010;24:221-25.

8. Whyte RK, Jefferies AL, Canadian Paediatric Society, Fetus and Newborn Committee.Red blood cell transfusion in newborn infants.*Paediatr Child Health*. 2014;19:213-17.

9. Rossi’s Principles of Transfusion Medicine, 6th Edition | Wiley. Wiley.com. Accessed December 18, 2022. https://www.wiley.com/e

n in/Rossi%27s+Principles+of+Transfusion+Medicine%2C+6th+Edition-p-9781119719755

10. Sola-Visner M. Platelets in the neonatal period: developmental differences in platelet production, function, and hemostasis and the potential impact of therapies. *Hematol Am SocHematolEduc Program*. 2012:506-11.

11. Girelli G, Antoncecchi S, Casadei AM, Del Vecchio A, Isernia P, Motta M, et al. Recommendations for transfusion therapy in neonatology. Blood Transfusion. 2015 ;13:484.

12. Neonate. Accessed January 17, 2023. https://www.datadictionary.nhs.uk/nhs_business_definitions/neonate.html.

13. Portugal CAA, de Paiva AP, Freire ES, Chaoubah A, Duarte MC, HallackNeto AE. Transfusion practices in a neonatal intensive care unit in a city in Brazil. *Rev Bras Hematol E Hemoter*. 2014;36:245-9.

14. Strauss RG. Transfusion therapy in neonates.*Am J Dis Child 1960*. 1991;145:904-11.

15. Blencowe H, Cousens S, Chou D, Oestergaard M, Say L, Moller AB, et al. Born too soon: the global epidemiology of 15 million preterm births. Reproductive health. 2013;10:1-4.

16. Cutland CL, Lackritz EM, Mallett-Moore T, Bardají A, Chandrasekaran R, Lahariya C,et al. Low birth weight: Case definition & guidelines for data collection, analysis, and presentation of maternal immunization safety data. Vaccine. 2017;35:6492.

17. Abubakari A, Kynast-Wolf G, Jahn A. Prevalence of abnormal birth weight and related factors in Northern region, Ghana. *BMC Pregnancy Childbirth*. 2015;15:335.

18. Low birth weight. Accessed January 18, 2023. https://www.who.int/data/nutrition/nlis/info/low-birth-weight

19. Simon LV, Hashmi MF, Bragg BN. APGAR Score. In: *StatPearls*. StatPearls Publishing; 2022.Accessed January 18, 2023. http://www.ncbi.nlm.nih.gov/books/NBK470569/

20. The Apgar Score | ACOG. Accessed January 18, 2023. https://www.acog.org/clinical/clinical guidance/committee opinion/articles/2015/10/the-apgar-score

21. Ibrahim MA, Supervisor AAM. Building a Classification Model to Identify the Effect of Apgar Score Factor on Cesarean Operation. In; 2019. Accessed January 18, 2023. https://www.semanticscholar.org/paper/Building a Classification Model to Identify the of Ibrahim Supervisor/0caf8b0fe6ff30afdba517712510f211858ba6b0/figure/2

22. Maier RF, Sonntag J, Walka MM, Liu G, Metze BC, Obladen M. Changing practices of red blood cell transfusions in infants with birth weights less than 1000 g. *J Pediatr*. 2000;136:220-4.

23. Murray NA, Roberts I a. G. Neonatal transfusion practice. *Arch Dis Child - Fetal Neonatal Ed*. 2004;89:101-7.

24. Martin RJ, Fanaroff AA, Walsh MC. *Fanaroff and Martin's Neonatal-Perinatal Medicine E-Book: Diseases of the Fetus and Infant*. Elsevier Health Sciences; 2014.

25. Morton SU, Brodsky D. Fetal Physiology and the Transition to Extrauterine Life.*ClinPerinatol*. 2016;43:395-407.

26. Hillman NH, Kallapur SG, Jobe AH. Physiology of transition from intrauterine to extrauterine life.*ClinPerinatol*. 2012;39:769-83.

27. Ayede AI, Akingbola TS. Pattern, indications and review of complications of neonatal blood transfusion in Ibadan, southwest Nigeria.*Ann Ib Postgrad Med*. 2011;9:30-6.

28. Giridharan J. Study of Blood Component Therapy in Neonates. 2013;4.

29. Dallman PR. Anemia of Prematurity.*Annu Rev Med*. 1981;32:143-60.

30. Linderkamp O, Zilow EP, Zilow G. [The critical hemoglobin value in newborn infants, infants and children]. *BeitrageZurInfusionstherapie ContribInfusTher*. 1992;30:235-246; discussion 247-264.

31. AABB Technical Manual 15TH.pdf. Accessed January 19, 2023. http://www.eqas.ir/pdf/lib/AABB%20Technical%20Manual%2015TH.pdf

32. Ohlsson A, Aher SM. Early erythropoiesis-stimulating agents in preterm or low birth weight infants. Cochrane Database Syst Rev. 2017;11:CD004863.

33. Sillers L, Slambrouck CV, Lapping Carr G. Neonatal Thrombocytopenia: Etiology and Diagnosis. *Pediatr Ann*. 2015;44:e175.

34. 503.full.pdf.Accessed January 19, 2023. https://adc.bmj.com/content/archdischild/64/4_Spec_No/503.full.pdf

35. Dogra K, Kaur G, Basu S, Chawla D. Fresh Frozen Plasma and Platelet Transfusion Practices in Neonatal Intensive Care Unit of a Tertiary Care Hospital. *Indian J Hematol Blood Transfus*. 2020;36:141-48.

36. Andrew M, Paes B, Milner R, Johnston M, Mitchell L, Tollefsen DM, et al. Development of the human coagulation system in the healthy premature infant. Blood. 1988;72:1651-7.
37. Motta M, Vecchio AD, Chirico G. Fresh Frozen Plasma Administration in the Neonatal Intensive Care Unit: Evidence-Based Guidelines. *ClinPerinatol*. 2015;42:639-50.
38. Jain R, Jose B, Coshic P, Agarwal R, Deorari AK. Blood and blood component therapy in neonates.*Indian J Pediatr*. 2008;75:489-95.
39. Roberts I, Murray N. Neonatal thrombocytopenia: causes and management. *Arch Dis Child Fetal Neonatal Ed*. 2003;88;359-64.
40. Christensen RD, Henry E, Jopling J, Wiedmeier SE. The CBC: reference ranges for neonates. *SeminPerinatol*. 2009;33:3-11.
41. Sparger K, Deschmann E, Sola-Visner M. Platelet Transfusions in the NICU. *ClinPerinatol*. 2015;42:613-23.
42. Kasat K, Hendricks-Muñoz KD, Mally PV. Neonatal red blood cell transfusions: searching for better guidelines. Blood Transfus. 2011;9:86-94.
43. Jain R, Jarosz CR, Myers TF. Decreasing blood donor exposure in the neonates by using dedicated donor transfusions. *Transfus Sci*. 1997;18:199-203.
44. Prasad L, Bhatty A, Banerjee S. Donor exposure in neonatal blood transfusion-time to change strategy?. Archives of Disease in Childhood. 2012;97:A84-.
45. Arora S, Marwaha N, Dhawan HK, Rao KLN. Dedicated donor unit transfusions reduces donor exposure in pediatric surgery patients. *Asian J Transfus Sci*. 2017;11:124-130.

46. Transfusion guidelines for neonates and older children - 2004 - British Journal of Haematology - Wiley Online Library. Accessed January 19, 2023. https://onlinelibrary.wiley.com/doi/10.1111/j.1365 2141.2004.04815.

47. Pattern and outcome of admissions to neonatal unit of Khyber Teaching Hospital, Peshawar. Accessed January 20, 2023. https://www.pjms.com.pk/issues/aprjun107/article/article22.html

48. Patterns and Determinants of Blood and Blood Products Transfusion in Neonate: An Experience of Single Institute | Open Access Macedonian Journal of Medical Sciences. Published online June 7, 2022. Accessed January 24, 2023. https://oamjms.eu/index .php/mjms/article/view/8641

49. Boo NY, Chan BH. Blood transfusion reactions in Malaysian newborn infants.*Med J Malaysia*.1998;53:358-64.

50. ShanmughaPriya RA, Krishnamoorthy R, Panicker VK, Ninan B. Transfusion support in preterm neonates <1500 g and/or <32 weeks in a tertiary care center: A descriptive study. *Asian J Transfus Sci*. 2018;12:34-41.

51. Batra D, Rabe H. Blood Transfusion Requirement in Multiple Birth Preterm Infants. *Pediatr Res*. 2011;70:613-13.

52. Ogunlesi TA, Ogunfowora OB. Pattern and determinants of blood transfusion in a Nigerian neonatal unit. *Niger J ClinPract*. 2011;14:354-58.

53. Qari SA, Alsufyani AA, Muathin SH. Prevalence of Respiratory Distress Syndrome in Neonates. *Egypt J Hosp Med*. 2018;70:257-64.

54. Kaur A, Dhir SK, Kaur G, Gupta M, Batta M. Blood component therapy in neonates in a neonatal intensive care unit of northern India. *ClinEpidemiol Glob Health*. 2015;3:38-42.

55. Factors Associated with Platelet Transfusions in Neonates Admitted in Intensive Care Unit in a Tertiary Care Centre RamanathanT1 , Maya Devi S2 ,K.C. Usha3https://www.ijcmr.com/uploads/7/7/4/6/77464738/1520_jul_24.pdf

56. Bowen JR, Patterson JA, Roberts CL, Isbister JP, Irving DO, Ford JB. Red cell and platelet transfusions in neonates: a population-based study. *Arch Dis Child Fetal Neonatal Ed*. 2015;100:411-5.

57. Neonatal and pediatric transfusion. Professional Education. Accessed January 21, 2023. https://professionaleducation.blood.ca/en/transfusion/clinical-guide/neonatal-and-pediatric-transfusion.

PROFORMA

Sr. No.	
NAME	
MRD No.	
FATHER's NAME	
ADDRESS	
DATE OF ADMISSION	
DATE OF DISCHARGE	
SEX	
BIRTH WEIGHT	

BIRTH GESTATION (WEEKS)	<32	33-35	>36

HEMOGRAM AT BIRTH	
BILIRUBIN AT BIRTH	
SpO2 AT BIRTH	
APGAR 0 MINUTES 5 MINUTES	

NEONATAL COMORBIDITIES		
PREMATURITY	YES	NO
RESPIRATORY DISTRESS SYNDROME	YES	NO
NEONATAL HYPERBILIRUBINEMIA	YES	NO
NECROTISING ENTEROCOLITIS	YES	NO
CONGENITAL MALFORMTION	YES	NO
ANY OTHER		

Signature of Candidate

Signature of Supervisor

	RESPIRATORY SUPPORT	YES	No. of days	NO
1	MECHANICAL VENTILLATION			
2	CPAP			
3	HIGH FLOW NASAL CANNULA			
4	NASAL OXYGEN PRONGS			
5	NONE			

INDICATION FOR TRANSFUSION

1) LOW Hb
2) SEPSIS WITH SHOCK
3) LOW SpO2
4) EVIDENT BLEEDING
5) THROMBOCYTOPENIA
6) PRE SURGERY
7) COAGULOPATHY
8) ENZYME DEFICIENCY
9) HYPERBILIRUBINEMIA
10) CARDIOPULMONARY SYNDROME
11) Rh INCOMPATABILITY
12) ANY OTHER:

PRODUCT TRANSFUSED	No. OF UNITS TRANSFUSED
PRBC	
RDP	
SDP	
FFP	
Cryoprecipitate	
Others	

BLOOD GROUP OF THE BABY	A+	B+	AB+	O+
	A-	B-	AB-	O-

Signature of Candidate

Signature of Supervisor

BLOOD GROUP OF THE BAG TRANSFUSED	A+	B+	AB+	O+
	A-	B-	AB-	O-

LAB VALUE	PRE TRANSFUSION	POST TRANSFUSION
Hb		
TLC		
PLT		
PT		
PT-INR		
SpO2		
BILIRUBIN		
ANY OTHER		

TRANSFUSION COMPLICATIONS:

1) TRANSFUSION REACTION

2) NEC

3) DISTRESS

4) ANY OTHER

5) NONE

OUTCOME:

1) DISCHARGED

2) LAMA

3) DEATH

Signature of Candidate

Signature of Supervisor

SR.NO	NAME	MRD	SEX	MULTIPLE BABY	AGE on 1st tfn (d)	BIRTH WEIGHT	BIRTH WEIGHT GROUP	Gestation	GEST ≤32	GEST >32-<36	GEST ≥36	Hb. (gm/dL)	TLC (103/ µL)
1	P	1232909	F	1	22	NW	4	3	N	N	Y	17	9
2	B-1	1244927	F	2	3	LBW	3	2	N	Y	N	17.4	9.6
3	S-1	1231311	M	2	20	ELBW	1	1	Y	N	N	14.5	10.4
4	S-2	1231317	M	2	20	ELBW	1	1	Y	N	N	16	5.6
5	KR	1228655	M	1	19	NW	4	3	N	N	Y	16.1	16.8
6	N	1237866	M	1	1	ELBW	1	1	Y	N	N	16.9	23.9
7	S	1212751	F	1	26	VLBW	2	2	N	Y	N	19.5	8.6
8	M	1218505	M	1	25	LBW	3	2	N	Y	N	21.9	11.3
9	S	1229574	M	1	2	LBW	3	2	N	Y	N	19.8	14.3
10	M	1215680	M	1	26	LBW	3	2	N	Y	N	17.2	6.9
11	SB	1185329	M	1	7	LBW	3	3	N	N	Y	16.3	11.1
12	JG	1212231	F	1	4	LBW	3	2	N	Y	N	16.4	10.3
13	MG	1223375	M	1	1	VLBW	2	1	Y	N	N	14.4	12.8
14	SK	1212751	F	1	26	NW	4	3	N	N	Y	19.5	8.6
15	MK 1	1215671	F	2	3	LBW	3	3	N	N	Y	13.7	5.9
16	AK	1219729	M	1	8	VLBW	2	1	Y	N	N	14.2	6.2
17	RG	1224879	F	1	19	NW	4	2	N	Y	N	16	8
18	CR	1203129	M	1	1	LBW	3	2	N	Y	N	18.3	15.4
19	VK	1203144	F	1	9	LBW	3	2	N	Y	N	14.9	18.9
20	MK	1192295	M	1	20	NW	4	2	N	Y	N	20.1	13.9
21	AM	1196701	F	1	3	NW	4	3	N	N	Y	20.7	13.3
22	A	1188036	M	1	15	LBW	3	2	N	Y	N	22.4	15.5
23	MS	1169931	F	1	2	LBW	3	3	N	N	Y	11.5	9.9
24	PK	1138219	M	1	6	ELBW	1	1	Y	N	N	12	17.9
25	M2	1133509	M	3	20	ELBW	1	1	Y	N	N	10.4	15.3
26	H	1116261	M	1	13	VLBW	2	2	N	Y	N	17.1	5.5
27	M	1138279	M	1	7	NW	4	3	N	N	Y	14	9.6
28	M	1167745	M	1	10	VLBW	2	2	N	Y	N	15	11
29	SK	1184474	M	1	14	ELBW	1	1	Y	N	N	13	14
30	RK	1178369	F	1	3	LBW	3	2	N	Y	N	16	15
31	RM	1166221	F	1	6	VLBW	2	2	N	Y	N	14	11
32	KK	1150396	F	2	2	ELBW	1	1	Y	N	N	13.8	10.9
33	MK	1147179	M	1	11	VLBW	2	1	Y	N	N	14	12
34	DK	1133499	F	1	7	VLBW	2	1	Y	N	N	15.7	9.3
35	SB	1185329	M	1	6	ELBW	1	1	Y	N	N	17	13
36	KW	1193377	M	1	5	NW	4	3	N	N	Y	12	14
37	RK	1094924	F	1	1	VLBW	2	1	Y	N	N	12	23.3
38	KK	1101098	M	1	20	VLBW	2	1	Y	N	N	9	18
39	IK	1110544	F	1	2	ELBW	1	1	Y	N	N	13.2	19
40	BK	1123816	M	1	1	VLBW	2	1	Y	N	N	17.2	8.9
41	RB	1123919	M	1	1	VLBW	2	1	Y	N	N	10	12
42	JK	1127202	M	2	11	ELBW	1	1	Y	N	N	14.9	19
43	SK	1141812	M	1	22	ELBW	1	1	Y	N	N	15.8	15.2
44	P	1180480	F	1	13	VLBW	2	1	Y	N	N	13.7	15.6
45	PB	1143238	M	2	11	VLBW	2	1	Y	N	N	10.2	6
46	SB	1185329	M	1	27	NW	4	3	N	N	Y	16.3	11.1
47	GP	1171505	M	1	12	VLBW	2	2	N	Y	N	23.2	7.9
48	SK	1249342	M	1	26	NW	4	3	N	N	Y	10.4	14.9
49	PK	1254647	M	1	12	LBW	3	2	N	Y	N	11.4	3.5
50	RK	1251306	F	1	8	NW	4	3	N	N	Y	13.6	22.2
51	PB	1258810	M	3	13	LBW	3	2	N	Y	N	15.9	22.6
52	NK	1279840	M	2	4	NW	4	3	N	N	Y	10.6	20
53	PB	1256825	M	3	11	LBW	3	2	N	Y	N	12.6	31.7
54	SS	1257706	M	1	4	NW	4	3	N	N	Y	19.7	9.3
55	PB2	1258808	F	3	9	VLBW	2	2	N	Y	N	15	19.7
56	MS	1267379	M	1	1	LBW	3	2	N	Y	N	14	8.3
57	G	1267353	M	1	4	NW	4	3	N	N	Y	16.4	17.8
58	PK	1122243	F	1	24	NW	4	3	N	N	Y	18.4	5.4
59	KG	1150399	M	3	2	ELBW	1	1	Y	N	N	13.8	10.9
60	PC	1154155	M	1	2	LBW	3	2	N	Y	N	17.4	19.6
61	SK	1141812	M	1	19	NW	4	3	N	N	Y	15.8	15.2
62	GK	1138858	M	1	8	NW	4	3	N	N	Y	15.3	9.4
63	SK	1172495	F	1	2	LBW	3	2	N	Y	N	15.3	12.4
64	HK	1184486	F	1	4	VLBW	2	1	Y	N	N	15.3	4
65	SK	1184474	M	1	28	NW	4	3	N	N	Y	16.3	4.9
66	VK	1203144	F	1	6	ELBW	1	1	Y	N	N	14.9	18.9
67	NK	1073314	F	1	6	NW	4	3	N	N	Y	15.9	16.4
68	JG	1212231	F	1	24	LBW	3	3	N	N	Y	16.4	10.3
69	SK	1217681	F	2	25	LBW	3	2	N	Y	N	17.2	5.6
70	HK	1271755	M	1	4	LBW	3	2	N	Y	N	10.4	44.8
71	NY2	1260857	F	1	3	LBW	3	2	N	Y	N	18	5.8

SR.NO	PLT (103/ µL)	BIL	SPO2	APGAR (0min)	APGAR (5min)	PREMATURITY	RDS	NEO HYPERBIL	NEC ENTEROCOLITIS	CONG MALF	OTHER	M.V	CPAP	N.C	N.O.P	NONE
1	315		98	8	9	N	N	N	N	N	N	N	N	N	N	Y
2	301		97	6	8	Y	N	N	N	N	N	N	N	N	N	Y
3	255		82	5	6	Y	Y	Y	N	N	N	Y	Y	Y	N	N
4	192		86	6	6	Y	Y	Y	N	N	N	Y	Y	Y	N	N
5	278		95	7	9	N	N	N	N	N	N	N	N	N	N	Y
6	210		84	5	6	Y	Y	Y	N	N	N	Y	N	N	N	N
7	192		87	6	7	Y	Y	N	N	N	N	Y	Y	Y	N	N
8	186		92	7	8	Y	Y	N	N	N	N	Y	Y	Y	Y	N
9	40		100	8	9	Y	N	N	N	N	N	N	N	N	N	Y
10	298		90	7	8	Y	Y	Y	N	N	N	Y	Y	Y	N	N
11	169		96	7	8	N	N	Y	N	N	N	Y	Y	Y	N	N
12	210		98	6	8	Y	Y	N	N	N	N	Y	Y	N	Y	N
13	165		92	5	6	Y	Y	N	N	N	N	Y	N	N	N	N
14	192		94	8	9	N	N	Y	N	N	N	N	N	N	N	Y
15	372		97	7	9	N	N	N	N	N	N	N	N	N	Y	N
16	186		91	6	7	Y	Y	Y	N	N	N	Y	N	N	N	N
17	215		86	5	7	Y	Y	N	N	N	N	Y	Y	N	Y	N
18	318		92	7	8	Y	N	N	N	N	N	N	N	N	N	Y
19	195		94	8	9	Y	N	N	N	N	N	N	N	N	Y	N
20	195		90	6	7	Y	N	N	N	N	N	N	Y	Y	N	N
21	341		99	8	9	N	N	N	N	N	N	N	N	N	N	Y
22	144		92	8	9	Y	Y	N	N	N	N	N	N	N	N	Y
23	223		96	8	9	N	N	Y	N	N	N	N	N	N	N	Y
24	169		97	6	8	Y	Y	N	N	N	N	Y	Y	N	N	N
25	100		98	8	9	Y	Y	N	N	N	N	Y	Y	N	Y	N
26	120		96	7	8	Y	Y	Y	N	N	N	Y	Y	N	N	N
27	450		99	9	10	N	N	N	N	N	N	N	N	N	N	Y
28	160		89	5	6	Y	Y	Y	Y	N	N	Y	Y	Y	N	N
29	250		93	7	8	Y	Y	N	N	N	N	N	Y	N	N	N
30	26		80	6	8	Y	Y	N	N	N	N	N	N	Y	N	N
31	250		99	8	9	Y	Y	N	N	N	N	N	Y	Y	Y	N
32	213		98	6	8	Y	Y	Y	N	N	N	Y	Y	Y	Y	N
33	180		99	7	8	Y	Y	N	N	N	N	Y	N	N	N	N
34	286		96	8	9	Y	Y	N	N	N	N	Y	Y	N	N	N
35	222		93	5	6	Y	Y	N	N	N	N	Y	Y	Y	N	N
36	180		95	7	8	N	N	N	Y	N	N	Y	N	N	N	N
37	228		97	5	8	Y	Y	N	N	N	N	Y	Y	N	Y	N
38	180		96	7	8	Y	Y	N	N	N	N	Y	Y	Y	N	N
39	270		98	3	7	Y	Y	N	Y	N	N	Y	Y	N	N	N
40	12		85	5	7	Y	Y	N	N	N	N	Y	N	N	N	N
41	70		94	7	9	Y	Y	N	N	N	N	Y	Y	Y	N	N
42	160		92	5	7	Y	Y	N	N	N	N	Y	N	N	N	N
43	299		98	6	8	Y	Y	N	N	N	N	Y	Y	Y	Y	N
44	373		96	5	7	Y	Y	N	N	N	N	Y	Y	Y	N	N
45	220		90	5	7	Y	Y	N	Y	N	ACHD	Y	N	N	N	N
46	169		99	8	9	N	N	N	N	N	N	N	N	N	Y	N
47	178		96	5	7	N	N	Y	N	N	N	N	Y	Y	N	N
48	240		100	7	8	N	N	Y	N	N	N	N	N	N	N	Y
49	53		87	5	7	Y	N	N	N	N	HYDROPS	N	Y	Y	Y	N
50	349		98	7	8	N	N	Y	N	N	N	N	N	N	N	Y
51	286		99	7	8	Y	N	Y	N	N	N	Y	Y	Y	N	N
52	45		97	8	9	N	N	N	N	N	N	N	N	N	N	Y
53	361		100	8	9	Y	N	N	N	N	N	N	N	N	N	Y
54	196		97	8	9	N	N	N	N	N	N	N	N	N	N	Y
55	373		98	5	7	Y	Y	Y	N	N	N	Y	Y	Y	N	N
56	20		97	7	8	Y	Y	N	N	N	N	N	N	Y	N	N
57	312		98	8	9	N	N	N	N	N	N	N	N	N	N	Y
58	234		99	7	8	N	N	N	N	N	N	N	N	N	N	Y
59	213		98	4	6	Y	Y	N	Y	N	N	Y	N	N	N	N
60	243		98	5	6	Y	Y	Y	N	N	N	Y	N	N	N	N
61	299		99	8	9	N	N	N	N	N	N	N	N	N	N	Y
62	199		99	7	9	N	N	N	N	N	N	N	N	N	N	Y
63	212		98	6	8	Y	Y	N	N	N	N	N	Y	N	N	N
64	365		99	4	6	Y	Y	Y	N	N	N	Y	N	N	N	N
65	181		98	8	10	N	N	N	N	N	N	N	N	N	N	Y
66	12		99	7	8	Y	Y	Y	N	N	N	Y	N	N	N	N
67	386		98	8	9	N	N	N	N	N	N	N	Y	Y	Y	N
68	210		98	7	9	N	N	N	N	N	N	N	N	N	N	Y
69	225		96	8	8	Y	N	N	N	N	N	N	N	N	N	Y
70	215		98	9	10	Y	Y	N	N	N	N	Y	N	N	N	N
71	136		99	9	10	Y	Y	Y	N	N	N	Y	Y	Y	Y	N

SR.NO	M-C-N-O	LOW Hb	S . S	LOW SPO2	BLEED	T. PENIA	SURG	COAG.	ENZYME	HIGH BIL	CPS	Rh INCOMP	OTHER	BABY BG
1		Y	Y	N	N	N	N	N	N	N	N	N	N	B+
2		Y	Y	N	N	N	N	N	N	N	N	N	N	B+
3	M-C-NC	Y	N	N	N	N	N	N	N	N	N	N	N	O+
4	M-C-NC	Y	N	Y	Y	Y	N	N	N	N	N	N	N	O+
5		Y	N	N	N	N	N	N	N	N	N	N	N	O+
6	M	Y	Y	Y	Y	N	N	Y	N	N	N	N	N	A+
7	M-C-M-NC	Y	N	Y	N	N	N	N	N	N	N	N	N	A+
8	M-C-NC-NOP	Y	Y	N	N	N	N	N	N	N	N	N	N	B+
9		N	N	N	N	Y	N	N	N	N	N	N	N	B+
10	M-C-NC	Y	N	N	N	N	N	N	N	N	N	N	N	B-
11	M-C-NC	Y	N	N	N	N	N	N	N	N	N	N	N	O+
12	M-C-NOP	Y	Y	Y	Y	Y	N	N	N	N	N	N	N	A+
13	M	Y	Y	Y	N	N	N	N	N	N	N	N	N	B+
14		N	N	N	N	N	N	N	N	Y	N	N	N	A+
15	NOP	Y	Y	N	N	N	N	N	N	N	N	N	N	B+
16	M	N	Y	Y	Y	Y	N	N	N	N	N	N	N	O+
17	M-C-M-NOP	Y	N	N	Y	Y	N	N	N	N	N	N	N	B-
18		N	Y	N	Y	Y	N	N	N	N	N	N	N	O+
19	NOP	N	Y	N	Y	N	N	N	N	N	N	N	N	A+
20	C-NOP	N	N	N	N	N	N	N	N	N	Y	N	N	O-
21		N	N	N	N	Y	N	N	N	N	N	N	N	O+
22		N	N	N	N	Y	N	N	N	N	N	N	N	O+
23		N	N	N	N	N	N	Y	N	N	N	N	N	O+
24	M-C	Y	N	N	N	N	N	N	N	N	N	N	N	B+
25	M-C-NOP-C-NOP	Y	Y	N	N	Y	N	N	N	N	N	N	N	O+
26	M-C	Y	N	N	N	N	N	N	N	N	N	N	N	O+
27		N	Y	N	N	Y	N	N	N	N	N	N	N	B+
28	M-C-M-C-N	Y	Y	Y	N	N	N	N	N	N	N	N	N	A+
29	C	N	Y	N	Y	Y	N	N	N	N	N	N	N	O+
30	C	N	N	N	N	Y	N	N	N	N	N	N	N	A+
31	C-NC-NOP	Y	N	N	Y	N	N	N	N	N	N	N	N	O+
32	M-C-M-NC-NOP	Y	Y	Y	Y	Y	N	N	N	N	N	N	N	AB+
33	M	N	N	N	N	Y	N	N	N	N	N	N	N	AB+
34	M-C-M	Y	Y	Y	Y	Y	N	Y	N	N	N	N	N	B+
35	M-C-M-C	Y	Y	N	N	N	N	N	N	N	N	N	N	O+
36	M	Y	Y	Y	N	N	N	N	N	N	N	N	N	B+
37	M-C-NOP	Y	N	N	N	N	N	N	N	N	N	N	N	O+
38	M-C-NC-M-C	Y	N	N	N	N	N	N	N	N	N	N	N	O+
39	M-C-M	Y	N	Y	N	N	N	N	N	N	N	N	N	B+
40	M	N	N	N	Y	Y	N	N	N	N	N	N	N	O+
41	M-C-NC	Y	N	N	N	Y	N	N	N	N	N	N	N	A+
42	M	Y	N	N	N	Y	N	N	N	N	N	N	N	A+
43	M-C-NC-NOP-C	Y	N	N	N	Y	N	N	N	N	N	N	N	O+
44	M-C-NC	N	Y	N	N	Y	N	N	N	N	N	N	N	A+
45	M	Y	N	N	Y	N	N	Y	N	Y	N	N	N	O+
46	NOP	Y	N	N	N	N	N	N	N	N	N	N	N	O+
47	C-NC	Y	N	N	N	Y	N	Y	N	Y	N	N	N	O-
48		Y	N	N	N	N	N	N	N	Y	N	Y	N	O+
49	C-NC-NOP	Y	N	N	Y	Y	N	N	N	N	Y	N	N	B+
50		Y	N	N	N	N	N	N	N	Y	N	N	N	A+
51	M-C-NC	Y	N	N	N	N	N	N	N	Y	N	N	N	O-
52		Y	N	N	N	Y	N	N	N	N	N	N	N	B+
53		Y	N	N	Y	Y	N	N	N	N	N	N	N	O+
54		N	N	N	N	Y	N	N	N	N	N	N	N	AB+
55	M-C-M-C-NC	Y	N	N	Y	Y	N	N	N	N	N	N	N	O+
56	NC	Y	N	N	Y	Y	N	Y	N	N	N	N	N	A-
57		N	N	N	N	Y	N	N	N	N	N	N	N	AB+
58		Y	Y	N	N	N	N	N	N	N	N	N	N	A+
59	M	N	N	N	Y	N	N	N	N	N	N	N	N	B+
60	M	Y	Y	N	Y	N	N	N	N	N	N	N	N	B+
61		N	N	N	Y	Y	N	N	N	N	N	N	N	O+
62		N	N	N	Y	N	N	N	N	N	N	N	N	A+
63	C	N	Y	N	N	N	N	N	N	N	N	N	N	B+
64	M	N	N	N	Y	N	N	Y	N	N	N	N	N	O+
65		N	N	N	Y	N	N	N	N	N	N	N	N	A+
66	M	N	Y	N	N	Y	N	N	N	N	N	N	N	A+
67	C-N-NOP	Y	Y	N	N	Y	N	Y	N	N	N	N	N	A+
68		N	Y	N	Y	Y	N	N	N	N	N	N	N	A+
69		N	Y	N	N	N	N	N	N	N	N	N	N	A+
70	M	Y	N	Y	N	N	N	N	N	N	N	N	N	B+
71	M-C-N-C-NOP	Y	Y	N	Y	Y	N	N	N	N	N	N	N	O+

SR.NO	BAG BG	Tansfused		PRBC	PRE Hb (g/dL)	POST Hb (g/dL)	FFP	PRE PT (sec)	POST PT (sec)	PRE INR	POST INR	RDP	PRE PLT (103/ µL)	POST PLT (103/ µL)	SDP
1	B+	1	PRBC	1	6.7	11.2									
2	B+	1	PRBC	2	8.9	11.8									
3	O+	1	PRBC	1	7.6	8.7									
4	O+	2	PRBC,RDP	1	7.8	10.8						1	15	13	
5	O+	1	PRBC	1	8.4	12.1									
6	A+	2	PRBC,FFP	1	5.3	9.5	3	20	13	3	1.3				
7	A+	1	PRBC	1	7.1	9.4									
8	B+	1	PRBC	2	9.2	12.6									
9	B+	1	RDP									2	40	100	
10	B-	1	PRBC	1	7.9	8.2									
11	O+	1	PRBC	2	8.4	10.7									
12	A+	1	PRBC	1	7.4	11									
13	B+	1	PRBC	1	6.7	10									
14	A+	1	PRBC	1	7.1	9.4									
15	B+	1	PRBC	1	8.3	11.3									
16	O+	2	PRBC,FFP	1	10.9		1	15		2					
17	B-	2	PRBC,RDP	1	7.7	11.4						1	64	79	
18	O+	1	RDP									1	118	130	
19	A+	1	RDP									1	171	199	
20	O-	1	PRBC	1	8.9	10.6									
21	AB+	1	RDP									2	14	16	
22	O+	1	RDP									1	117	132	
23	O+	1	FFP				1	18.1		1.65					
24	B+	1	PRBC	1	6.8	10.5									
25	O+	3	PRBC,FFP,RDP	1	7.3	10.2	1	17.2	11	2.6	2	1	44	148	
26	O+	1	PRBC	1	7.6	10.1									
27	B+	1	RDP									1	24	150	
28	A+	1	PRBC	2	7.4	12.4									
29	O+	2	PRBC,RDP	1	11	14						1	42	90	
30	A+	1	RDP									6	20	80	
31	O+	1	PRBC	1	8	12.4									
32	AB+	2	PRBC,RDP	2	10	14						4	35	84	
33	AB+	1	RDP									3	45	130	
34	B+	2	PRBC,FFP	5	7	11	3	20	12	3.4	1.8				
35	O+	1	PRBC	2	7	9									
36	B+	1	PRBC	1	8	11									
37	O+	1	PRBC	1	9	13									
38	O+	1	PRBC	2	7	11									
39	B+	1	PRBC	2	7.3	9									
40	O+	1	RDP									2	48	110	
41	A+	2	PRBC,RDP	1	10	13						2	40	160	
42	A+	2	PRBC,RDP	2	7	12						2	135	200	
43	O+	2	PRBC,RDP	1	8	10.5						1	34	72	
44	A+ (AB+ RDP)	2	PRBC,RDP	2	9	13						1	127	93	
45	O+	2	PRBC,FFP	1	12		3	17.1		1.51					
46	O+	1	PRBC	1	6.2	6.8									
47	O+, B+	1	RDP									2	24	32	
48	O+	1	PRBC	1	10.6	12.2									
49	B+	3	PRBC,FFP,RDP	2	9	12	4	46.3	26.5	4.19	2.41	3	53	78	
50	A+	1	PRBC	1	7.4	12.4									
51	O-	1	PRBC	2	7	9.4									
52	B+	2	PRBC,RDP	1	8	12						2	45	66	
53	O+	2	PRBC,RDP	1	10.5	10.4						2	107	150	
54	AB+	1	RDP									2	45	120	
55	O+	2	PRBC,RDP	1	8.9	11.3						2	22	78	
56	A-	3	PRBC,FFP,RDP	1	7.7	12.3	1	17.5	11	1.6	1.2	2	42	238	
57	A+	1	RDP									1	22	173	
58	A+	1	PRBC	1	6.6	12.7									
59	B+	1	RDP									1	34		
60	B-, O-	1	PRBC	3	8.3	13.6									
61	O+	2	PRBC,RDP	1	6.7	10.7						1	34	72	
62	A+	1	PRBC	1	5.9	10.1									
63	B+	2	PRBC,FFP	1	7.7		2	41.1		1.33					
64	O+	1	FFP				1								
65	A+	1	PRBC	2	7.7	9.4									
66	A+	1	RDP									1	12	46	
67	A+	3	PRBC,FFP,RDP	1	5.9	8.5	1	26.6	13.1	0.86	1.2	1	18	40	
68	A+	2	PRBC,RDP	2	7.4	11.6						2	30	146	
69	A+	1	PRBC	1	6.5	7.4									
70	B+	1	PRBC	1	7.1	9.4									
71	O+	2	PRBC,RDP	3	6.9	9.3						1	80	134	

SR.NO	PRE PLT	POST PLT	PRE SPO2	POST SPO2	PRE BIL	POST BIL	OTHER	T.R	NEC	DISTRESS	OTHER	NONE	OUTCOME
1			96	98				N	N	N	N	Y	DISCHARGE
2			95	98				N	N	N	N	Y	DISCHARGE
3			98	99				N	Y	N	N	N	DEATH
4			96	97				N	N	N	N	Y	DEATH
5			95	97				N	N	N	N	Y	DISCHARGE
6			98	99				N	N	N	N	Y	DEATH
7			96	98				N	N	Y	N	N	DISCHARGE
8			96	99				N	N	N	N	Y	DEATH
9			96	97				N	N	N	N	Y	DISCHARGE
10			99	98				N	N	N	N	Y	DISCHARGE
11			96	99				N	N	Y	N	N	LAMA
12			99	99				N	N	N	N	N	LAMA
13			96	97				N	Y	Y	N	N	DEATH
14			98	99				N	N	N	N	Y	DISCHARGE
15			97	98				N	N	N	N	Y	DISCHARGE
16			95	95				N	N	Y	N	N	DEATH
17			96	96				N	N	N	N	Y	DISCHARGE
18			97	98				N	N	N	N	Y	DISCHARGE
19			97	97				N	N	N	N	Y	DISCHARGE
20			95	95				N	Y	N	N	N	DISCHARGE
21			97	99				N	N	Y	N	N	DEATH
22			97	95				N	N	Y	N	N	DISCHARGE
23			95	0				N	N	N	N	Y	DEATH
24			97	99				N	Y	N	N	N	LAMA
25			99	99				N	Y	Y	N	N	DEATH
26			97	97				N	N	N	N	Y	DISCHARGE
27			98	99				N	N	N	N	Y	DISCHARGE
28			97	99				N	N	Y	N	N	LAMA
29			99	99				N	N	N	N	Y	DISCHARGE
30			98	99				N	N	N	N	Y	LAMA
31			99	99				N	N	N	N	N	DISCHARGE
32			99	99				N	N	N	N	N	DISCHARGE
33			98	97				N	Y	Y	N	N	DEATH
34			99	99				N	N	N	N	N	DISCHARGE
35			98	99				N	N	N	N	Y	DISCHARGE
36			99	99				N	Y	N	N	N	LAMA
37			97	98				N	N	N	N	Y	DISCHARGE
38			96	99				N	N	N	N	Y	LAMA
39			99	97				N	N	N	N	Y	DISCHARGE
40			98	98				N	N	N	N	Y	DISCHARGE
41			97	98				N	N	N	N	Y	DISCHARGE
42			98	99				N	N	Y	N	N	DEATH
43			98	99				N	N	N	N	N	DEATH
44			98	99				N	N	N	N	N	DEATH
45			97	0				N	N	Y	N	N	DEATH
46			98	99				N	N	N	N	Y	DISCHARGE
47			98	99				N	N	N	N	Y	DEATH
48			99	99				N	N	N	N	Y	DISCHARGE
49			99	99				N	N	Y	N	N	DISCHARGE
50			99	99				N	Y	N	N	N	LAMA
51			99	98				N	N	Y	N	N	DEATH
52			98	96				N	N	N	N	Y	DISCHARGE
53			97	98				N	N	N	N	Y	DISCHARGE
54			98	99				N	N	N	N	Y	DISCHARGE
55			98	99				N	N	Y	N	N	DEATH
56			99	99				N	N	N	N	N	DISCHARGE
57			98	99				N	N	N	N	Y	DISCHARGE
58			95	96				N	Y	N	N	N	DEATH
59			95	0				N	N	Y	N	N	DEATH
60			98	99				N	N	Y	N	N	LAMA
61			99	99				N	Y	N	N	N	DISCHARGE
62			99	99				N	N	N	N	Y	DISCHARGE
63			99	98				N	N	Y	N	N	DEATH
64			97	98				N	N	Y	N	N	DEATH
65			99	98				N	N	N	N	Y	DISCHARGE
66			99	97				N	N	N	N	N	DEATH
67			98	99				N	Y	Y	N	N	DEATH
68			99	99				N	N	N	N	Y	DISCHARGE
69			99	99				N	Y	Y	N	Y	DEATH
70			99	99				N	N	Y	N	N	DEATH
71			98	98				N	N	N	N	Y	DEATH

SR.NO	NAME	MRD	SEX	MULTIPLE BABY	AGE on 1st tfn (d)	BIRTH WEIGHT	BIRTH WEIGHT GROUP	Gestation	GEST ≤32	GEST >32-<36	GEST ≥36	Hb. (gm/dL)	TLC (103/ µL)
72	KK	1351441	M	1	4	VLBW	2	1	Y	N	N	12.5	2.2
73	BK	1369152	M	1	11	NW	4	3	N	N	Y	17.5	17.2
74	SR2	1303441	M	3	6	LBW	3	2	N	Y	N	14.7	18.8
75	HK	1350573	M	1	16	VLBW	2	1	Y	N	N	16.1	10.9
76	KG	1370981	M	1	5	LBW	3	3	N	N	Y	17.3	45
77	SR2	1348767	M	2	5	VLBW	2	1	Y	N	N	14.5	7.08
78	MM	1373139	F	1	20	LBW	3	2	N	Y	N	16.1	12.8
79	RK	1375441	M	1	16	LBW	3	2	N	Y	N	16.4	13
80	JJ	1375801	F	1	15	NW	4	3	N	N	Y	15.2	12.6
81	HG	1383147	M	1	21	NW	4	3	N	N	Y	17	11
82	MM	1387850	M	1	12	LBW	3	3	N	N	Y	13	14
83	CG	1388658	F	1	3	LBW	3	2	N	Y	N	14	11
84	SK1	1386183	F	3	6	ELBW	1	1	Y	N	N	15	5
85	GK	1390429	M	1	18	NW	4	3	N	N	Y	16.2	7
86	S	1390610	M	1	21	VLBW	2	2	N	Y	N	13	9
87	GV	1392013	M	1	25	NW	4	3	N	N	Y	15.4	10
88	H	1396501	F	1	27	NW	4	3	N	N	Y	17	15
89	PB	1400799	M	1	6	NW	4	3	N	N	Y	15.7	11
90	KK	1256711	F	1	8	VLBW	2	2	N	Y	N	12	15
91	SG	1386596	F	1	11	NW	4	3	N	N	Y	15	9
92	SG	1392164	M	1	19	LBW	3	2	N	Y	N	13	10
93	KK1	1403024	M	2	24	VLBW	2	1	Y	N	N	11	15.6
94	MK	1403150	F	1	11	LBW	3	2	N	Y	N	14	11
95	P	1404694	M	1	10	NW	4	3	N	N	Y	14.3	15
96	PP	1405410	M	1	9	LBW	3	2	N	Y	N	13	12
97	N	1402000	F	1	4	VLBW	2	1	Y	N	N	11	16
98	CS	1400904	M	1	8	VLBW	2	1	Y	N	N	10	14
99	P2	1400335	M	1	2	LBW	3	2	N	Y	N	13.5	11
100	KK2	1403028	F	3	13	ELBW	1	1	Y	N	N	11	16

SR.NO	PLT (103/ µL)	BIL	SPO2	APGAR (0min)	APGAR (5min)	PREMATURITY	RDS	NEO HYPERBIL	NEC ENTEROCOLITIS	CONG MALF	OTHER	M.V	CPAP	N.C	N.O.P	NONE
72	269		98	7	7	Y	Y	N	Y	N	N	Y	Y	N	N	N
73	285		97	7	10	N	N	N	N	N	N	N	N	N	N	Y
74	272		97	9	10	Y	N	N	N	N	N	N	N	N	N	N
75	244		99	7	9	Y	Y	N	N	N	N	Y	Y	N	N	N
76	152		92	5	7	Y	N	N	N	N	N	N	N	N	N	Y
77	252		94	6	7	Y	Y	Y	N	N	N	Y	Y	N	N	N
78	295		95	5	6	Y	Y	Y	N	N	N	N	N	Y	Y	N
79	270		98	8	9	Y	Y	Y	N	N	N	N	Y	N	Y	N
80	290		99	8	9	N	N	N	N	N	N	N	N	N	N	Y
81	230		99	9	10	N	N	N	N	N	N	N	N	N	N	N
82	222		97	7	8	N	N	Y	N	N	N	N	N	N	Y	N
83	90		94	8	9	Y	Y	Y	N	N	N	Y	Y	Y	Y	N
84	180		99	7	8	Y	Y	Y	N	N	N	Y	Y	N	N	N
85	111		96	9	10	N	N	N	N	N	N	N	N	N	Y	N
86	270		98	8	9	Y	Y	Y	N	N	N	Y	Y	Y	N	N
87	202		99	9	10	N	N	Y	N	N	N	N	N	N	N	Y
88	175		93	8	9	N	N	N	N	N	N	N	N	N	Y	N
89	180		97	9	10	N	N	Y	N	DOWNS	N	N	N	Y	Y	N
90	164		99	6	8	Y	Y	Y	N	N	N	Y	Y	Y	N	N
91	277		95	9	10	N	N	N	N	N	N	N	N	N	Y	N
92	342		99	6	7	Y	N	N	N	N	N	N	Y	Y	N	N
93	135		98	7	7	Y	Y	Y	N	N	N	Y	Y	N	N	N
94	243		98	8	8	Y	Y	Y	N	N	N	N	Y	Y	Y	N
95	222		99	9	10	N	N	N	N	N	N	N	Y	Y	N	N
96	246		97	7	8	Y	N	Y	N	N	N	N	Y	Y	Y	N
97	118		95	7	9	Y	Y	N	N	N	N	Y	Y	N	N	N
98	200		99	6	8	Y	Y	Y	N	N	N	Y	Y	Y	N	N
99	69		96	9	10	Y	Y	Y	N	N	N	Y	Y	N	N	N
100	87		99	6	7	Y	Y	Y	N	N	N	Y	Y	Y	Y	N

SR.NO	M-C-N-O	LOW Hb	S . S	LOW SPO2	BLEED	T. PENIA	SURG	COAG.	ENZYME	HIGH BIL	CPS	Rh INCOMP	OTHER	BABY BG
72	M-C-M	Y	Y	Y	Y	Y	Y	N	N	N	N	N	N	O+
73		N	N	N	Y	N	N	Y	N	N	N	N	N	A+
74		Y	N	Y	N	N	N	N	N	N	N	N	N	O+
75	M-C	Y	Y	N	N	N	N	N	N	N	N	N	N	AB+
76		N	Y	N	N	Y	N	N	N	N	N	N	N	A+
77	M-C	N	N	Y	Y	N	N	N	N	N	N	N	N	O+
78	N-NOP	N	Y	N	N	N	N	N	N	N	N	N	N	B+
79	C-NOP	Y	N	N	Y	N	N	N	N	N	N	N	N	A+
80		N	N	N	Y	Y	N	N	N	N	N	N	N	A+
81		N	N	N	N	Y	N	N	N	N	N	N	N	B+
82	NOP	Y	Y	N	N	N	N	N	N	N	N	N	N	O+
83	M-C--N-C-NOP	N	N	N	N	Y	N	N	N	N	N	N	N	O+
84	M-C-M	Y	Y	Y	Y	N	N	N	N	N	N	N	N	A+
85	NOP	Y	N	N	Y	Y	N	Y	N	N	N	N	N	A+
86	M-C-N	Y	N	N	N	N	N	N	N	N	N	N	N	B+
87		N	N	N	Y	N	N	Y	N	N	N	N	N	A+
88	NOP	N	N	N	N	Y	N	N	N	N	N	Y	N	B+
89	N-NOP-N	Y	N	N	Y	Y	N	N	N	N	N	N	N	A+
90	M-C-M-C-N	Y	Y	N	Y	Y	N	N	N	N	N	N	N	AB+
91	NOP	N	N	N	Y	N	N	Y	N	N	N	N	N	B+
92	C-N	Y	N	N	N	N	N	N	N	N	N	N	N	O+
93	M-C	Y	Y	Y	Y	N	N	Y	N	Y	N	Y	N	A+
94	C-N-NOP	N	N	N	Y	Y	N	N	N	N	N	N	N	O+
95	C-N	Y	Y	N	N	N	N	Y	N	N	N	N	N	A+
96	C-N-NOP	Y	N	N	N	N	N	N	N	N	N	N	N	O+
97	M-C	Y	Y	Y	Y	Y	N	Y	N	N	N	N	N	B-
98	M-C-N-C-N	Y	Y	N	N	Y	N	N	N	N	N	N	N	AB+
99	M-C	Y	N	N	N	N	N	N	N	N	N	N	N	B+
100	M-C-N-NOP-N-NOP	Y	Y	N	Y	Y	N	N	N	N	N	N	N	O+

SR.NO	BAG BG	Tansfused		PRBC	PRE Hb (g/dL)	POST Hb (g/dL)	FFP	PRE PT (sec)	POST PT (sec)	PRE INR	POST INR	RDP	PRE PLT (103/ µL)	POST PLT (103/ µL)	SDP
72	O+	2	PRBC,RDP	3	7	11						3	60	130	
73	A+	1	FFP				2	11.7	12.9	1.07	1.18				
74	O+	1	PRBC	3	8.4	10.9									
75	AB+	1	PRBC	3	7.7	11.3									
76	A+	1	RDP									3	30	97	
77	O+	2	PRBC,RDP	3	8.9	11.7						1	92	140	
78	B+	1	PRBC	1	9.1	12.4									
79	A+	1	PRBC	2	8.1	11.8									
80	A+	1	RDP									2	42	98	
81	B+	1	RDP									1	48	79	
82	O+	1	PRBC	1	9	13									
83	B+	1	RDP									3	43	130	
84	A+	3	PRBC,FFP,RDP	2	7.4	9.5	1	13.2	14	3.2	1.6	3	65	98	
85	A+	2	PRBC,RDP	1	8.2	11.4						2	40	140	
86	B+	1	PRBC	2	11	14.6									
87	A+	1	FFP				2	15.8	10.2	4	2				
88	B+	1	RDP									2	56	98	
89	A+	2	PRBC,RDP	1	10	13						1	74	110	
90	A+	2	PRBC,RDP	4	8	11						2	35	95	
91	B+	1	FFP				1	18	12	3	1.6				
92	O+	1	PRBC	2	9.2	14.6									
93	A+	3	PRBC,FFP,RDP	3	7	12	3	28	15	4.2	2	2	90	160	
94	B+	1	RDP									1	73	148	
95	A+	2	PRBC,FFP	1	9.4	14.2	2	18.4	11.2	3.2	1.6				
96	O+	1	PRBC	1	10.4	14									
97	B-	3	PRBC,FFP,RDP	2	7	11	3	25.2	13	4	2.3	2	70	110	
98	AB+	2	PRBC,RDP	1	9	12						1	85	138	
99	B+	1	PRBC	1	8.6	10.4									
100	O+	3	PRBC,FFP,RDP	2	9.2	13.4	3	20	13	5	2.2	2	57	99	

SR.NO	PRE PLT	POST PLT	PRE SPO2	POST SPO2	PRE BIL	POST BIL	OTHER	T.R	NEC	DISTRESS	OTHER	NONE	OUTCOME
72			99	99				N	N	Y	N	N	DEATH
73			99	98				N	N	N	N	Y	DISCHARGE
74			98	99				N	Y	Y	N	N	DISCHARGE
75			99	97				N	Y	N	N	N	DISCHARGE
76			98	99				N	N	Y	N	N	LAMA
77			99	98				N	N	Y	N	N	DEATH
78			98	99				N	N	N	N	Y	DISCHARGE
79			99	99				N	N	N	N	Y	DISCHARGE
80			99	99				N	N	N	N	Y	DISCHARGE
81			99	99				N	N	N	N	Y	DISCHARGE
82			99	99				N	N	Y	N	N	DISCHARGE
83			99	99				N	N	N	N	Y	DISCHARGE
84			99	99				N	Y	Y	N	N	DEATH
85			100	100				N	N	N	N	N	DISCHARGE
86			99	99				N	N	Y	N	N	DISCHARGE
87			99	99				N	N	N	N	Y	DISCHARGE
88			99	99				N	N	N	N	Y	DISCHARGE
89			99	99				N	N	N	N	Y	DISCHARGE
90			99	99				N	Y	Y	N	N	DEATH
91			99	99				N	N	N	N	Y	DISCHARGE
92			99	99				N	N	N	N	Y	DISCHARGE
93			99	99				N	N	Y	N	N	DEATH
94			100	100				N	N	N	N	N	DISCHARGE
95			99	99				N	N	N	N	Y	DISCHARGE
96			99	99				N	N	N	N	Y	DISCHARGE
97			98	99				N	N	Y	N	N	DEATH
98			99	99				N	N	N	N	Y	DISCHARGE
99			99	99				N	N	Y	N	N	LAMA
100			99	100				N	N	N	N	Y	DISCHARGE

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Date 09/11/22

The Principal,
DMC, Ludhiana.

Subject: **Approval of Plan of Thesis.**

This is to inform you that the Faculty of Medical Sciences in its meeting held on 29.10.2021 has approved the plan of thesis of **Kaveri Joshi**, a student of your college for **MD Immuno Haematology & Blood Transfusion** along with the names of Supervisor/Co-Supervisor as under:-

Topic Plan of Thesis
Clinical determinants and pattern of blood and blood component transfusion in neonates.

Supervisor
Dr. Amarjit Kaur
Prof. & Head,
Dept. of I.H.B.T.,
DMCH, Ludhiana.

Co-Supervisor

Dr. Rajesh Kumar
Prof.,
Dept. of I.H.B.T.,
DMCH, Ludhiana.

Dr. Kamaldeep Arora
Assoc. Prof.,
Dept. of Paediatrics,
DMCH, Ludhiana.

The student has to submit the four copies of thesis (along with PDF format) , to the Controller of Examinations, BFUHS, Faridkot, at least six months before the commencement of theory examination, if he/she is otherwise eligible to take the examination. He /She must directed to attach a photocopy of this letter with the forwarding letter while submitting thesis to the University along with the letter of approval of University for change of supervisor/Co-Supervisor, change of topic,(if any).

Dr. S P Singh MS(Oph)
Controller of Examinations

Note :

63. *If any discrepancy found regarding topic of thesis or Supervisor/Co-Supervisor, inform undersigned within one month after issue of this letter.*
64. *The student may submit the thesis as per the schedule already conveyed i.e for May/June examination 30th Nov of the preceding the year of examination and for Nov/Dec examinations 31st May of the year of examination.*

CLINICAL DETERMINANTS AND PATTERN OF BLOOD AND BLOOD COMPONENT TRANSFUSION IN NEONATES

THESIS PROPOSAL

FOR APPROVAL OF SUBJECT OF THESIS TO BE SUBMITTED

IN PARTIAL FULFILMENT OF THE REQUIREMENTS

FOR THE DEGREE OF

DOCTOR OF MEDICINE

In

IMMUNOHEMATOLOGY AND BLOOD TRANSFUSION

OF THE

BABA FARID UNIVERSITY OF HEALTH SCIENCES

FARIDKOT

MARCH 2021

Dr. Kaveri Joshi

DEPARTMENT OF IMMUNOHEMATOLOGY AND BLOOD TRANSFUSION
DAYANAND MEDICAL COLLEGE & HOSPITAL, LUDHIANA
LUDHIANA, PUNJAB-141001

ABSTRACT OF PLAN OF THESIS

Title	CLINICAL DETERMINANTS AND PATTERN OF BLOOD AND BLOOD COMPONENT TRANSFUSION IN NEONATES
For the degree of	M.D.
Name of the candidate	Dr. Kaveri Joshi
Supervisor	Dr. Amarjit Kaur, Professor & Head, Department of I.H.B.T, DMCH, Ludhiana
Co-supervisor	Dr. Rajesh Kumar, Professor, Department of I.H.B.T, DMCH, Ludhiana Dr. Kamaldeep Arora, Associate Professor, Department of Paediatrics, DMCH, Ludhiana
Institution	Dayanand Medical College and Hospital, Ludhiana
University	Baba Farid University of Health Sciences, Faridkot

Introduction: Transfusions in low birth weight preterm infants treated on neonatal intensive care units (NICUs) are a common practice. Neonates with sepsis, uncontrolled hyperbilirubinemia, neonates requiring repeated phlebotomy, coagulopathies, or neonates requiring major surgeries, G6PD deficiency are often recipients of blood transfusion. Blood transfusion is required to maintain life, by increasing the cardiac output and oxygen delivery to tissues, and removing toxins like bilirubin from the body. Due to smaller volumes, transfusion services need to be directed at neonates in a special manner

Aim of Study:

- To determine the clinical indications for blood and blood component transfusion in neonatal population.
- To standardize the protocols for blood transfusion based on statistical data.

Materials & Methods: Neonates admitted to our hospital will be included in this study. All neonates transfused with blood or blood component will be identified using case files, HIS and blood bank records and clinical determinants of transfusion will be recognized.

Clinical Significance: To rationalize the use of blood products in neonates in order to reduce antigen exposure and complications related to blood transfusion. To standardize the protocol for blood and blood component transfusion in neonates.

Keywords: Neonate, blood component, blood transfusion

(Signature)	(Signature)	(Signature)	(Signature)	(Signature)
Candidate	Co-supervisor	Co-supervisor	Supervisor	Principal

CERTIFICATE OF FACILITIES AVAILABLE

This is to certify that the facilities for work on the subject of thesis titled **"CLINICAL DETERMINANTS AND PATTERN OF BLOOD AND BLOOD COMPONENT TRANSFUSION IN NEONATES"** exist in the Department of Immunohematology and Blood Transfusion at Dayanand Medical College and Hospital, Ludhiana and will be provided to the candidate. We will see that the data being included in the thesis are genuine and is collected by the candidate herself under our supervision and guidance.

Supervisor

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DMCH, Ludhiana

Co-Supervisor

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Dr. Kamaldeep Arora
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Place: DMCH, LUDHIANA

Date: 12-03-2021

APPROVAL PROFORMA
BY
RESEARCH & ETHICAL COMMITTEE
DAYANAND MEDICAL COLLEGE & HOSPITAL, LUDHIANA

Name of candidate	Dr. Kaveri Joshi
Department	Immunohematology and Blood Transfusion
Topic of Thesis	CLINICAL DETERMINANTS AND PATTERN OF BLOOD AND BLOOD COMPONENTS TRANSFUSION IN NEONATES
Likely date of appearing in PG examination	MAY-JUNE 2023
Date of enrollment	27th July 2020
Name of Head of Department	Dr. Amarjit Kaur
1) Supervisor **2) Co-Supervisor**	Dr. Amarjit Kaur Dr. Rajesh Kumar Dr. Kamaldeep Arora
Signature of Members of Research Committee with Stamp	**Signature of Members of Ethics Committee with Stamp**
Dr. Harpreet Kaur (Professor & Head, Pathology)	Mr. R K Sharma (Legal Expert)
Dr. Jaspal Singh (Professor & Head, Surgery)	Dr. Ramit Mahajan (Associate Professor, Gastroenterology)
Dr. Dinesh Gupta (Professor & Head, Medicine)	Dr. Anu Sharma (Professor, Anatomy)
Dr. Sandeep Kaushal (Dean Academics & Professor & Head, Pharmacology)	Dr. Sandeep Kaushal (Dean Academics & Professor & Head, Pharmacology)
Dr. Gurpreet S Wander (Vice Principal)	Dr. Gurpreet S Wander (Vice Principal & Professor & Head, Cardiology)
	Dr. Gagandeep Singh (Secretary, Ethics Committee Professor & Head, Neurology)

Approved: Yes / No

Dr. Sandeep Puri
Chairperson
Research Committee

Approved: Yes / ~~No~~

Prof. Arvind Malhotra
Chairperson
Ethics Committee

BABA FARID UNIVERSITY OF HEALTH SCIENCES, FARIDKOT

PROFORMA FOR REGISTRATION OF SUBJECT FOR DISSERTATION

1.	NAME OF THE CANDIDATE AND ADDRESS	Dr. Kaveri Joshi 28-29 Joshi Farms, A block, Guru Amardass Avenue, Airport Road, Amritsar
2.	NAME OF THE INSTITUTE	DAYANAND MEDICAL COLLEGE AND HOSPITAL, LUDHIANA
3.	COURSE OF STUDY AND SUBJECT	M.D., I.H.B.T.
4.	DATE OF ADMISSION OF COURSE	27th JULY, 2020
5.	TITLE OF THE TOPIC	Clinical determinants and pattern of blood and blood component transfusion in neonates.

6. BRIEF RESUME OF THE INTENDED WORK

6.1 NEED FOR THE STUDY

Blood transfusion is an indispensible form of medical procedure, particularly in pediatric practice, where common illnesses are usually associated with blood destruction or blood loss.[1] The procedure replaces the volume and the specific constituents of blood, which play specific roles in oxygen carriage, immunity, and clotting. Therefore, blood transfusion is required to maintain life, by increasing the cardiac output and oxygen delivery to tissues, and removing toxins like bilirubin from the body.[2]

A newborn infant or neonate is defined as a child under 28 days of age.[3]

The need for transfusion in the neonate may occur due to physiological or pathological causes. The leading causes of neonatal morbidities and mortality in the developing world include mechanical and chemical birth injuries, infections, and jaundice.[4] These conditions may be associated with hemolysis, disorders of coagulation or accumulation of potential toxins. Bleeding disorders in neonates often require blood transfusion.[5] In such instances, blood transfusion is required to prevent death from acute circulatory collapse or severe hypoxemia.[6]

The most frequent indications for blood transfusion in the newborn are the acute treatment of perinatal hemorrhagic shock and the recurrent correction of anemia of prematurity. Perinatal hemorrhagic shock requires immediate treatment with large quantities of red blood cells Newborns, particularly extremely low birth weight infants who are most exposed to transfusion, are already immunologically compromised and neurodevelopmentally vulnerable.

Anemia of prematurity is, in part, an exacerbation of the physiological anemia of the newborn, combining a suppressed postnatal response to erythropoietin, increased blood sampling, short RBC span in the newborn and the rapid increase in blood volume with growth.[7] Apart from hemoglobin or hematocrit, there are no satisfactory clinical or laboratory guides to assist the decision to transfuse[8]

RBCs are the most commonly transfused blood products in neonates. A majority of ELBW infants require at least one transfusion, and many receive multiple transfusions.[9,10] A clear relationship between low platelet counts and consequential clinical bleeding or major hemorrhage has not been established in neonates. Evidence guiding the transfusion of plasma, of all blood products, in neona tes is the weakest. Although there are a few prospective multicenter studies exploring plasma use in neonates[11], we rely largely on expert opinion to make recommendations for plasma transfusions.[12]

Neonates admitted in a tertiary neonatal intensive care unit (NICU) require multiple blood transfusions because of extended NICU stay and repeated sampling. The rookie organ systems and miniature blood volumes in the neonate call for regular audits in neonatal blood transfusion practice. Multiple physiological changes occur when a fetus becomes a neonate. These changes refer to an alteration in their blood volume, hematological parameters, and other body systems. Stress to adapt in an extrauterine environment leads to a blunted capacity of premie to produce erythrocytes, thrombocytes, and immune cells, i.e., neutrophils. The blood volume in a full-term newborn is approximately 85 ml/kg while that in a preterm newborn is about 100 ml/kg and that in an adult is about 70 ml/kg. The miniature blood volume and rookie organ systems in the neonate call for novel proposals in neonatal blood transfusion practice.[14]

Therefore, a study is needed to analyse the specific clinical indications to transfuse the newborn to reduce unnecessary transfusion and subsequent antigen exposure in these young individuals.

6.2 REVIEW OF LITERATURE

Blood transfusion is an essential therapy, particularly in neonates, where common illnesses are usually related to blood destruction or blood loss. The procedure helps to re-establish specific functions of oxygen carriage, immunity, and clotting.

There occurs in neonate a dramatic and rapid change in physiology in almost all organs systems. Most of this can be attributed to fast growth of the newborn infant and changes in the haematological domain. It can be manifest as erythropoietin and/or iron deficiency inherent to neonates, due to low erythropoiesis and the shorter life span of fetal haemoglobin,[15] low levels of Vitamin K dependent clotting factors and contact factor.[16] So, it bears mentioning that for the foundation of a healthy childhood and adulthood further down, special care is needed during this precarious period right from birth, to first few days of life and during the remaining neonatal period.[17]

Physiologically, healthy full-term neonates have a mean cord blood haemoglobin level of 16.9 ± 1.6 g/dL and that of preterm neonates is 15.9 ± 2.4 g/dL. The haemoglobin concentration usually falls off during the first few weeks of life, leading to physiological anaemia of infancy in newborns and physiological anaemia of prematurity in preterm infants.[18]

Anemia of prematurity is a physiological phenomenon, which is related to the inadequate maternofetal transfer of iron and poor postnatal production of endogenous erythropoietin in infants. Although, replacement therapy with synthetic erythropoietin is a common practice in the developed world, blood transfusion is commonly used in parts of the developing world, where recombinant erythropoietin is unavailable. Top-up transfusion with red cells is done for anemic cases, while exchange blood transfusion (EBT) is recommended for hyperbilirubinemia. In some cases of severe hyperbilirubinemia, EBT is required to rapidly remove the excess bilirubin from the blood, to prevent irreversible brain damage known as bilirubin encephalopathy.[6]

Preterm infants of very low birth weight have very little iron stores and a small circulating volume of RBCs when they exit the uterine stage, as

can be expected with low reserves and small circulatory volumes, the effects of loss of even small blood volumes can be profoundly lethal for the neonates.[19]

In a Nigerian study, Half of the transfusions in took place during the first week of life, thus, indicating the role of perinatal events in the conditions warranting transfusion. Exchange blood transfusion (EBT) was most commonly carried out toward the end of the first week of life. Thus, jaundice was obviously the most prominent indication for transfusion in this study. This implied that aggressive prevention of severe hyperbilirubinemia using effective phototherapy would prevent the bulk of EBT Further to this was the observation that preterm babies often require multiple transfusions compared to term babies. This might be related to the greater physiological predisposition of preterm babies to anemia compared to term babies.[6]

For newborn transfusion, there are specific considerations for blood-banking procedures. Newborns, particularly extremely low birth weight infants who are most exposed to transfusion, are already immunologically compromised and neurodevelopmentally vulnerable. All transfusion-transmitted infections put the newborn at risk, but cytomegalovirus (CMV) infection may have serious consequences for more immature infants.[8]

Although transfusions overall are increasingly safe, neonates, especially extremely preterm neonates, are particularly predisposed to transfusion complications, including acute reactions such as transfusion-associated circulatory overload (TACO) and transfusion-associated acute lung injury (TRALI).[11]

One of the major problems with deciding when to transfuse is the lack of a clearly identified and agreed-upon definition of severe anemia in neonates. Owing to the absence of a universally accepted definition of anemia in neonates necessitating an RBC transfusion and to the wide age-specific reference range of acceptable hematocrit values, treatment thresholds are not standardized. The most premature of infants have the highest risk of developing thrombocytopenia.

One of the major problems with deciding when to transfuse is the lack of a clearly identified and agreed-upon definition of severe anemia in neonates. Owing to the absence of a universally accepted definition of anemia in neonates necessitating an RBC transfusion and to the wide age-specific reference range of acceptable hematocrit values, treatment thresholds are not standardized. The most premature of infants have the highest risk of developing thrombocytopenia. Consequently, platelets are the second most commonly transfused blood component in neonates, next to RBCs.

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The recent guidelines from the British Society of Hematology (BSH) recommend that for stable children younger than 4 months, prophylactic platelet transfusion should be given at a platelet count of less than 30 × 109 /L and for stable children older than 4 months, prophylactic platelet transfusions should be given at a platelet count of less than 10 × 109 /L. The guidelines admit that, given the lack of studies in pediatrics, the platelet transfusion indication for critically ill children or those with hematologic and oncologic malignancies who develop severe thrombocytopenia is based on adult study data. Evidence guiding the transfusion of plasma, of all blood products, in neonates is the weakest. Current expert opinion supports the “therapeutic” use of plasma either with active bleeding or concurrent to invasive procedures in patients at high risk of bleeding and those recognized to have an abnormal coagulation profile. An abnormal coagulation profile would be identified as the conventional coagulation parameters prothrombin time (PT) or activated partial thromboplastin time (aPTT) being significantly above the normal age and gestation adjusted reference ranges. Although plasma is usually transfused for its hemostatic properties, there have been reports of an association between plasma transfusion and venous thrombotic outcomes in neonatal as well as pediatric patients, with the coagulation factors and

According to the 2019 british society for hematology guidelines, The majority of extremely preterm neonates (<28 weeks gestation) receive at least one red cell transfusion as they frequently become anaemic, partly caused by phlebotomy losses (note: a 0·5 ml blood sample in a 500 g infant (1 ml/kg), is roughly equivalent to a 70 ml sample in a 70 kg adult), Potential benefits of transfusion in this group include improved tissue oxygenation and a lower cardiac output to maintain the same level of oxygenation.

platelet-derived microparticles in plasma being considered responsiblefor the thrombotic effects.[12]

Red cells suitable for neonatal exchange are irradiated and 'fresh' (before the end of Day 5 following donation, with a 24-h shelf-life post-irradiation in order to reduce the risk of recipient hyperkalaemia. They have a controlled Hct 0·5–0·6, in order to reduce the risk of both post-exchange anaemia and polycythaemia. They are negative for high-titre anti-A and anti-B antibodies (HT negative). The majority of red cell transfusions to neonates are top-up transfusions of small volumes (traditionally 10–20 ml/kg, typically 15 ml/kg over 4 h) given to replace phlebotomy losses in the context of anaemia of prematurity, particularly for preterm VLBW neonates. It seems prudent to use top-up transfusion volumes of 15 ml/kg for non-bleeding neonates in most cases. Neonatal purpura fulminans (PF) may be the presenting feature of a severe deficiency of either protein C (PC) or, less commonly, protein S (PS).. Neonatal PF is a haematological emergency characterized by skin necrosis and DIC that may progress rapidly to multi-organ failure. Early recognition is crucial to reduce morbidity and mortality. While PC concentrate has better efficacy in the management of PC deficiency, early empiric FFP (15–20 ml/kg given 8–12 hourly) is likely to be required until the diagnosis is confirmed and PC concentrate is made available. FFP is the only available treatment for severe PS deficiency Neonatal red cell exchange transfusion is mainly used in the treatment of severe hyperbilirubinaemia or anaemia in babies with HDFN. It removes antibody-coated neonatal red cells and

reduces the level of plasma unconjugated bilirubin (the cause of bilirubin encephalopathy). The steep decline in the incidence of HDFN following the introduction of maternal anti-D Ig prophylaxis, more effective antenatal monitoring and treatment, and the use of intensive phototherapy and intravenous immunoglobulin postnatally has made red cell exchange transfusion an uncommon procedure that should only be performed in specialist units by experienced staff. A ‘double volume exchange’ (160–200 mL/kg) removes around 90% of neonatal red cells and 50% of bilirubin.[14]

Large-volume transfusion, equivalent to a single circulating blood volume (approximately 80 mL/kg), is mainly used in neonatal cardiac surgery while Repeated small-volume ‘top-up’ red cell transfusions (up to 20 mL/kg) are commonly carried out in preterm babies, mainly to replace losses from repeated blood testing exacerbated by reduced red cell production (‘anaemia of prematurity’).[6]

Platelet production in the intrauterine life starts at around 5 weeks after conception and by the end of the second trimester has established the normal postnatal range of 150–450 ×109 /L. Reference ranges derived from a large population of babies having blood counts in hospital show a lower (5th centile) limit of 105× 109 /L for those born 32 weeks of gestation and 125 ×109 /L for those >32 weeks of gestation. Postnatal infants born at 28 weeks or 3 earlier usually present with a lower platelet count than those infants who are more mature at birth, which is probably due to their postnatal clinical course as well as reduced marrow reserve.[20]

The leading causes of neonatal morbidity and mortality include respiratory distress, sepsis, low birth weight, prematurity, birth asphyxia, congenital malformation, jaundice and others.[21] The most common indications for blood transfusions were sepsis and prematurity.[15] RBCs are indicated in sepsis because sepsis leads to the oxidative haemolysis and thus necessitates where transfused RBCs are necessary to maintain circulatory homeostasis.[15]

A neonate's blood volume is tiny compared to the large transfusion bags they frequently receive. For a 2.5 kg neonate, the total blood volume is approx 210 ml. Multiple physiological changes occur when a fetus becomes a neonate. These changes refer to an alteration in their blood volume, hematological parameters, and other body systems. Stress to adapt in an extrauterine environment leads to a blunted capacity of premie to produce erythrocytes, thrombocytes, and immune cells, i.e., neutrophils. The blood volume in a full-term newborn is approximately 85 ml/kg while that in a preterm newborn is about 100 ml/kg and that in an adult is about 70 ml/kg. The miniature blood volume and rookie organ systems in the neonate call for novel proposals in neonatal blood transfusion practice. In the said study, a statistically significant correlation is found between neonatal birth weight and multiple transfusion needs ($p = 0.01$). Low birth weight neonates required more transfusions. The majority required transfusion due to neonatal sepsis, disseminated intravascular coagulopathy, low birth weight, respiratory distress syndrome, and unconjugated hyperbilirubinemia. No transfusion-related complications were observed in the study. Hematocrit was the primary determinant for transfusing RCC to a neonate. Opinion-based practice was favored widely in the absence of evidence-based protocols. Neonatologists often transfuse plasma in the neonate with a deranged coagulation profile without any clue of active hemorrhage, despite a lack of data to prove the effectiveness of this practice. Coagulation protein levels keep fluctuating depending on the gestational age of the neonate. This should be taken into account while interpreting prothrombin time (PT) and activated partial thromboplastin time (aPTT). Prolonged PT and aPTT are seen in premature infants due to the decreased synthetic function of hepatocytes. But prematurity itself is not an indication for transfusing fresh frozen plasma. Hemoglobin level in neonates differs from adults because they are age dependent. Neonates have a hemoglobin level of 19 g/dl at birth, which dips down to 11.2 g/dl when they reach infancy. The study concluded that, Low birth weight and prematurity are the two risk factors identified that lead to multiple blood

transfusions. Fresh frozen plasma was the most commonly transfused component, and the indication was neonatal sepsis. Whole blood is still used and must be avoided.[13]

6.3 AIMS AND OBJECTIVES OF THE STUDY

- To determine the clinical indications for blood and blood component transfusion in neonates
- To formulate the protocols for blood transfusion based on statistical data.

7. MATERIALS AND METHODS

The study will be performed on neonates admitted in Neonatal Intensive Care Unit (NICU) to determine the clinical indications and pattern of usage of blood and blood components. Neonates who require transfusion with blood or blood component during their hospital stay will be included in the study. The following data will be obtained: sex, age and weight at the time of first transfusion, indication for transfusion and the presence of specific clinical disorders like seizure, apnea, dyspnea, jaundice or obvious bleeding. Depending on the gestational age of mother, the newborn can be classified into term baby and preterm baby. A preterm baby is defined as a baby born alive before 37 weeks of pregnancy is completed. Preterm babies are sub classified into various categories, based on gestational age namely extremely preterm ((<28 weeks), very preterm (28 to <32 weeks) and moderate to late preterm (32 to <37 weeks).[22] Term birth or baby is defined as a baby born after 37 weeks of pregnancy.[23]

According to the birth weight of the neonate, they are classified into normal birth weight (•2500 gm), Low Birth weight neonates (2499 – 1500 gm), Very Low Birth weight (1499 – 1000 gm) and Extremely Low Birth weight (<1000 gm) neonates.[24]

A total of 100 neonates will be enrolled in the study starting from April 15, 2021 to April 15, 2022. Clinical determinants for transfusion like dyspnea, intracranial hemorrhage, indication for major surgery, severe hyperbilirubinemia will be identified and recorded.

The british journal of hematology guidelines on Blood and blood component transfusion (2019) will be followed during the course of this study. The guidelines for transfusion of PRBC according to age, level of sickness and hematocrit are as follows

Guidelines for PRBC transfusion thresholds in preterm neonates (<32 weeks)

Postnatal age	Suggested transfusion threshold Hb (g/dL)		
	Ventilated	On oxygen or CPAP/ NIPPV	No supplemental oxygen
First 24 hr	<12	<12	<10
Days 2 to 7	<12	<10	<10
Days 8 to 14	<10	<9.5	<7.5 – 8.5
Day 15 onwards	<10	<8.5	<7.5

Guidelines for PRBC transfusion thresholds in term neonates

Condition	Hb (g/dL)
Severe pulmonary disease	<12
Moderate pulmonary disease	<10
Severe cardiac disease	<12
Major surgery	<10
Symptomatic anemia	<7

Suggested thresholds for neonatal platelet transfusion

Platelet Count	Condition
<25,000 / cubic mm	Neonates with no bleeding (including neonates with NAIT if no bleeding and no family history of ICH)
<50,000 / cubic mm	• Neonates with bleeding • Evidence of coagulopathy • Before surgery • NAIT if previously affected sibling with ICH
<1,00,000 / cubic mm	Major bleeding e.g. significant IVH Major surgery

NAIT, neonatal alloimmune thrombocytopenia; ICH, intracranial haemorrhage. Adapted with permission from British Committee for Standards in Hematology: Guidelines on transfusion for fetuses, neonates and older children 2016.

Pediatric dosing of blood components

Component	Dose	Expected increment
Red Blood Cells Fresh Frozen Plasma	10-15 mL/kg 10-15 mL/kg	Hemoglobin increase 2-3g/dL 15%-20% rise in factor levels (assuming 100% recovery)
Platelets (whole-blood-derived (WBD) or apheresis)	5-10 mL/kg or 1 WBD unit/10 kg (patients 10 kg)	50,000/µL rise in platelet count (assuming 100% recovery)

Effect of transfusion in terms of clinical improvement and laboratory values like blood cell counts, hemoglobin concentration and tissue oxygenation will be recorded and used to analyze the determinants and outcome of transfusion.

7.1 SOURCE OF DATA

Inclusion Criteria:

- All neonates admitted in NICU who require blood or blood component transfusion during their hospital stay.

Exclusion Criteria:

- Neonates with major congenital deformities
- The neonates who die within first 24 hours of life.

7.2 METHOD OF COLLECTION OF DATA

Neonates admitted in NICU from April 15, 2021 to March15, 2022 will be the subject of this study. Clinical course during their hospital stay will be followed and on the need arising for blood or blood component transfusion clinical determinants like dyspnea, intracranial hemorrhage, indication for major surgery, severe hyperbilirubinemia will be identified and recorded. Lab values like hemoglobin concentration, blood cell counts, oxygenation values will be recorded both pre and post

transfusion to analyze the advantages and disadvantages of transfusion to the neonate.

7.3 DOES THE STUDY REQUIRE ANY INVESTIGATIONS OR INTERVENTIONS TO BE CONDUCTED ON PATIENTS OR OTHER HUMANS OR ANIMALS? IF SO, PLEASE DESCRIBE BRIEFLY.

No

7.4 HAS ETHICAL CLEARENCE BEEN OBTAINED FROM YOUR INSTITUTION IN CASE OF 7.3?

Yes

LIST OF REFERENCES

1. Gorst DW. Haemorrhagic disorders and the use of blood products. In: Hendrickse RG, Barr DG, Matthews TS, editors. Paediatrics in the Tropics. 1st ed, Oxford: Blackwell Scientific Publications; 1991. p. 360-72.
2. Strauss RG. Transfusion therapy in neonates. Am J Dis Child 1991;145: 904. 2. Strauss RG. Transfusion therapy in neonates. Am J Dis Child 1991;145: 904.
3. World Health Organization. Infant, Newborn. [Online]. 2017 [cited 2017 Sep 30]; Available from: URL:http://www.who.int/topics/infant_newborn/en/
4. Ogunlesi TA, Ogunfowora OB, Adekanmbi AF, Fetuga MB, Runsewe-Abiodun TI, Ogundeyi MM. Neonatal mortality at Olabisi Onabanjo University Teaching Hospital, Sagamu. Niger J Paediatr 2006;33:40-6.
5. Ogundeyi MM, Ogunlesi TA. Approach to the bleeding neonate. Niger J Med 2009;18:238-43.
6. Ogunlesi TA, Ogunfowora OB. Pattern and determinants of blood transfusion in a Nigerian neonatal unit. Nigerian journal of clinical practice. 2011;14(3):354-8.
7. Strauss RG. Anaemia of prematurity: Pathophysiology and treatment. Blood Rev. 2010;24(6):221-5.
8. Whyte RK, Jefferies AL. Canadian Paediatric Society, Fetus and Newborn Committee. Red blood cell transfusion in newborn infants. Paediatr Child Health. 2014;19(4):213–222. Am J Perinatol. 2006;23:451-8.
9. Maier RF, Sonntag J, Walka MM, Liu G, Metze BC, Obladen M. Changing practices of red blood cell transfusions in infants with birth weights less than 1000 g. The Journal of pediatrics. 2000;136(2):220-4.
10. Keir AK, Yang J, Harrison A, Pelausa E, Shah PS, Canadian Neonatal Network. Temporal changes in blood product usage in preterm neonates born at less than 30 weeks' gestation in Canada. Transfusion. 2015;55(6):1340-6.

11. Motta M, Del Vecchio A, Perrone B, Ghirardello S, Radicioni M. Fresh frozen plasma use in the NICU: a prospective, observational, multicentred study. Archives of Disease in Childhood-Fetal and Neonatal Edition. 2014;99(4):F303-8.
12. Goel R, Josephson CD. Recent advances in transfusions in neonates/infants. F1000Research. 2018;7:609.
13. Amrutiya RJ, Mungala BM, Patel VT, Ganjiwale JD, Nimbalkar SM. Blood Component Transfusion in Tertiary Care Neonatal Intensive Care Unit and Neonatal Intermediate Care Unit: An Audit. Cureus. 2020;12(8).:e9952.
14. BRITISH SOCIETY FOR HEMATOLOGY GUIDELINES FOR NEONATE TRANSFUSION. 2019.
15. Portugal CA, Paiva AP, Freire ÉS, Chaoubah A, Duarte MC, Hallack Neto AE. Transfusion practices in a neonatal intensive care unit in a city in Brazil. Revista brasileira de hematologia e hemoterapia. 2014;36(4):245-9.
16. Fung MK, Grossman BJ, Hillyer CD, Westhoff CM. Chapter 23 Neonatal and pediatric transfusion practice. AABB Technical Manual 18th Edition p571.
17. National Neonatology Forum India. Evidence based Clinical Practice Guidelines. [Online]. 2010 Oct [cited 2017 Sep 30]; Avaiable from: URL:www.nnfpublication.org
18. O'Brien RT, Pearson HA. Physiologic anemia of the newborn infant. J Pediatr 1971;79(1):132-8.
19. Simon TL, McCullough J, Snyder E, Solheim BG, Strauss RG. Rossi's Principle of Transfusion Medicine. 5th ed. United Kingdom: John Wiley & Sons; 2016.
20. Carr R, Kelly AM, Willaimson LM. Neonatal thrombocytopenia and platelet transfusion – a UK perspective. Neonatology 2015;107:1-7.
21. Carr R, Kelly AM, Willaimson LM. Neonatal thrombocytopenia and platelet transfusion – a UK perspective. Neonatology 2015;107:1-7.

22. World Health Organization. Preterm birth. [Online]. 2017 [cited 2017 Sep 30]; Available from: URL:http://www.who.int/mediacentre/factsheets/fs363/en/s
23. American Congress of Obstetricians and Gynaecologists. Definition of Term pregnancy. [Online]. 2017 [cited 2017 Sep 30]; Available from: URL:http://www.acog.org/Resources-And-Publications/CommitteeOpinions/Committee-on-Obstetric-Practice/Definition-of-Term-Pregnancy
24. World Health Organization. Newborns with low birth weight. [Online]. 2017 [cited 2017 Sep 30]; Available from: URL:http://www.who.int/whosis/whostat2006NewbornsLowBirthWeight.pdf.

PROFORMA

Sr. No.	
NAME	
MRD No.	
FATHER's NAME	
ADDRESS	
DATE OF ADMISSION	
DATE OF DISCHARGE	
SEX	
BIRTH WEIGHT	

BIRTH GESTATION (WEEKS)	<32	33-35	>36

HEMOGRAM AT BIRTH	
BILIRUBIN AT BIRTH	
SpO2 AT BIRTH	
APGAR 0 MINUTES 5 MINUTES	

NEONATAL COMORBIDITIES		
PREMATURITY	YES	NO
RESPIRATORY DISTRESS SYNDROME	YES	NO
NEONATAL HYPERBILIRUBINEMIA	YES	NO
NECROTISING ENTEROCOLITIS	YES	NO
CONGENITAL MALFORMTION	YES	NO
ANY OTHER		

Signature of Candidate

Signature of Supervisor

	RESPIRATORY SUPPORT	YES	No. of days	NO
1	MECHANICAL VENTILLATION			
2	CPAP			
3	HIGH FLOW NASAL CANNULA			
4	NASAL OXYGEN PRONGS			
5	NONE			

INDICATION FOR TRANSFUSION

1) LOW Hb
2) SEPSIS WITH SHOCK
3) LOW SpO2
4) EVIDENT BLEEDING
5) THROMBOCYTOPENIA
6) PRE SURGERY
7) COAGULOPATHY
8) ENZYME DEFICIENCY
9) HYPERBILIRUBINEMIA
10) CARDIOPULMONARY SYNDROME
11) Rh INCOMPATABILITY
12) ANY OTHER:

PRODUCT TRANSFUSED	No. OF UNITS TRANSFUSED
PRBC	
RDP	
SDP	
FFP	
Cryoprecipitate	
Others	

BLOOD GROUP OF THE BABY	A+	B+	AB+	O+
	A-	B-	AB-	O-

Signature of Candidate

Signature of Supervisor

BLOOD GROUP OF THE BAG TRANSFUSED	A+	B+	AB+	O+
	A-	B-	AB-	O-

LAB VALUE	PRE TRANSFUSION	POST TRANSFUSION
Hb		
TLC		
PLT		
PT		
PT-INR		
SpO2		
BILIRUBIN		
ANY OTHER		

TRANSFUSION COMPLICATIONS:

1) TRANSFUSION REACTION

2) NEC

3) DISTRESS

4) ANY OTHER

5) NONE

OUTCOME:

1) DISCHARGED

2) LAMA

3) DEATH

Signature of Candidate

Signature of Supervisor

INFORMED PATIENT CONSENT

Date: _____

I.....D/o, W/o, S/o..... .....am willing to participate in the study **"CLINICAL DETERMINANTS AND PATTERN OF BLOOD AND BLOOD COMPONENT TRANSFUSION IN NEONATES"** The procedure with its complications has been explained to me in local vernacular language. I have fully understood that no special tests and extra expenditure in any form, merely for the purpose of thesis is being carried out. I am free to opt out the study any time without assigning any reason.

....

Signature of the Witness Signature of the patient

Name:

Signature of Supervisor **Signature of Candidate**

मरीज अनुमति फार्म

तिथि _____

मैं _____ पत्नी/पुत्र/पुत्री _____ निवासी _____ इस शोधकार्य **"CLINICAL DETERMINANTS AND PATTERN OF BLOOD AND BLOOD COMPONENT TRANSFUSION IN NEONATES"** में भाग लेने के लिए सहमत हूँ। मैं इस शोधकार्य में भाग लेने के लिए अपनी स्वेच्छा से तैयार हूँ। मैं पुष्टि करता/करती हूँ की यह स्वीकृति देने के लिए मुझे कोई आर्थिक प्रलोभन नहीं दिया गया और न ही दबाव डाला गया है। मुझे इस शोधकार्य का उद्देश्य स्पष्ट कर दिया गया है और मुझे यह विश्वास है की यह विज्ञान और मानवता के लाभ के लिए है। मुझे इस शोधकार्य में होने वाले जोखिम के बारे में समझा दिया गया है और मेरी समझ में यह जोखिम बहुत मामुली है।

मैं इस शोधकार्य में भाग लेने के सम्बन्ध में किसी भी समय अपनी अस्वीकृति व्यक्त कर सकता/सकती हूँ और मेरे अस्वीकृति व्यक्त करने का मेरे इलाज पर कोई प्रभाव नहीं पड़ेगा।

_____ _____

गवाह के हस्ताक्षर रोगी के हस्ताक्षर/अंगूठे का निशान

नाम: नाम:

_____

अन्वेषक के हस्ताक्षर

_____

विद्यार्थी के हस्ताक्षर

ਮਰੀਜ਼ ਰਜ਼ਾਮੰਦੀ ਫਾਰਮ

ਮਿਤੀ_____

ਮੈ_____ਪਤਨੀ/ਪੁੱਤਰ/ਪੁੱਤਰੀ_____ਵਾਸੀ

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"CLINICAL DETERMINANTS AND PATTERN OF BLOOD AND BLOOD COMPONENT TRANSFUSION IN NEONATES" ਤੇ ਚਲ ਰਹੀ ਖੋਜ ਵਿਚ ਹਿੱਸਾ ਲੈਣ ਲਈ ਰਜ਼ਾਮੰਦ ਹਾਂ। ਇਸ ਖੋਜ ਕੰਮ ਵਿਚ ਹਿੱਸਾ ਲੈਣ ਲਈ ਮੈ ਆਪਣੀ ਮਰਜ਼ੀ ਨਾਲ ਤਿਆਰ ਹਾਂ। ਮੈ ਇਹ ਦਸਣਾ ਚਾਹੁੰਦਾ ਹਾਂ/ ਚਾਹੁੰਦੀ ਹਾਂ ਕੇ ਇਹ ਰਜ਼ਾਮੰਦੀ ਦੇਣ ਵਾਸਤੇ ਮੈਨੂ ਕਿਸੇ ਵੀ ਤਰਾਂ ਦਾ ਲੋਭ-ਲਾਲਚ ਨਹੀ ਦਿੱਤਾ ਗਿਆ ਅਤੇ ਨਾ ਹੀ ਕੋਈ ਦਬਾ ਪਾਇਆ ਗਿਆ ਹੈ। ਮੈਨੂ ਇਸ ਖੋਜ ਦਾ ਮਨੋਰਥ ਸਮਝਾ ਦਿੱਤਾ ਗਿਆ ਹੈ ਅਤੇ ਮੈਨੂ ਇਹ ਭਰੋਸਾ ਦਵਾਇਆ ਗਿਆ ਹੈ ਕੇ ਇਹ ਖੋਜ ਵਿਗਿਆਨ ਅਤੇ ਮਾਨਵਤਾ ਦੀ ਭਲਾਈ ਲਈ ਹੈ। ਮੈਨੂ ਇਸ ਖੋਜ ਵਿਚ ਹੋਣ ਵਾਲੇ ਖਤਰੇ ਬਾਰੇ ਸਮਝਾ ਦਿੱਤਾ ਗਿਆ ਹੈ ਅਤੇ ਮੈਨੂ ਇਹ ਯਕੀਨ ਹੈ ਕੇ ਇਹ ਖਤਰਾ ਬਹੁਤ ਮਾਮੂਲੀ ਹੈ। ਮੈਨੂ ਇਸ ਖੋਜ ਕੰਮ ਵਿਚ ਹਿੱਸਾ ਲੈਣ ਦਾ ਢੰਗ – ਤਰੀਕਾ ਸਮਝਾ ਦਿੱਤਾ ਗਿਆ ਹੈ।

ਮੈ ਇਸ ਖੋਜ ਕੰਮ ਵਿਚ ਹਿੱਸਾ ਲੈਣ ਬਾਰੇ ਆਪਣੀ ਰਜ਼ਾਮੰਦੀ ਕਿਸੇ ਵੀ ਸਮੇ ਵਾਪਸ ਲੈ ਸਕਦਾ ਹਾਂ/ ਸਕਦੀ ਹਾਂ ਅਤੇ ਮੇਰੀ ਰਜ਼ਾਮੰਦੀ ਵਾਪਸ ਲੈਣ ਦਾ ਮੇਰੇ ਇਲਾਜ ਤੇ ਕੋਈ ਅਸਰ ਨਹੀ ਹੋਵੇਗਾ।

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ਗਵਾਹ ਦੇ ਹਸਤਾਖਰ ਮਰੀਜ਼ ਦੇ ਹਸਤਾਖਰ

ਮਿਤੀ_____ ਮਿਤੀ_____

ਪਤਾ _____ ਪਤਾ _____

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ਨਿਰੀਖਕ ਦੇ ਹਸਤਾਖਰ

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ਸਿਖਿਆਰਥੀ ਦੇ ਹਸਤਾਖਰ